THURSDAY, FEBRUARY 19, 1891.

REPTILIA AND BATRACHIA OF BRITISH INDIA.

The Fauna of British India, including Ceylon and Burma. Published under the authority of the Secretary of State for India in Council. Edited by W. T. Blanford. "Reptilia and Batrachia." By George A. Boulenger. (London: Taylor and Francis, 1890.)

MORE than a quarter of a century has passed since Dr. Günther's "Reptiles of British India"[1] appeared. Externally, it has little in common with the present book. Dr. Günther's work is large, and not very handy; but it is adorned with 26 plates, which, as unmatched gems of modern lithography, possess enduring artistic value. Mr. Boulenger's work, which may be taken as a sort of second edition of the older book, is a volume of moderate size, with a number of simply executed woodcuts, which, consisting for the most part of diagrammatic outlines, are intended merely to aid the student in comprehending the structure of the skull and pholidosis. In one respect, however, and that the most important, the two books have a remarkable resemblance to one another. Both trace new paths for the classification of the animals with which they deal.

While the herpetological fauna of the entire south-eastern continental part of Asia is treated in Dr. Günther's "Reptiles of British India," Mr. Boulenger limits himself in the present work to British India, with Burma and Ceylon. Nevertheless, the number of species described by Mr. Boulenger is considerably greater than that described by Dr. Günther. The Reptiles described include 3 Crocodilia, 43 Chelonia, 225 Lacertilia, 1 Rhiptoglossa, and 264 Ophidia; the Batrachia include 124 Ecaudata, 1 Caudata, and 5 Apoda.

Looking more closely at the rich contents of the book, we need not say much about the majority of the orders of Reptiles and Batrachia, because the systematic as well as the descriptive treatment of the families, genera, and species does not differ greatly from the results he has set down in his masterly British Museum Catalogues—results which are now the common property of the naturalists of all nations. The only new contribution, corresponding better to present scientific needs, is the separation of the chamæleons from the lizards, and the consequent division of the Squamata into the three sub-orders of the Lacertilia, the Rhiptoglossa, and the Ophidia.

On the other hand, the classification of the snakes, which comprise nearly one-half of the Reptilian species known to occur in India, appears to be completely new; and all the descriptions of families, genera, and species have been prepared expressly for the present work. As no recent publication contains a complete synonymy of the Ophidia, the author explains that somewhat fuller references to the literature of the subject have been rendered necessary than in the other sub-orders of Reptiles and Batrachians. He has abandoned the old primary division of snakes into poisonous and non-poisonous. This division he properly regards as unscientific; "and," he adds, "although adopted almost generally, it is in so far incorrect that a number of forms (Opisthoglypha) usually ranked as harmless are really poisonous, although their bite may be without effect on man and large animals." Experiments recently made by Peracca and Deregibus on Cœlopeltis, and by Vaillant on Dryophis, "have shown that these snakes are poisonous, and that they paralyze their small prey before deglutition." Mr. Boulenger regards it as probable that "all snakes with grooved teeth will prove to be poisonous, to a greater or less degree, as it is clear, *a priori*, that these grooved fangs are not without a function." He has therefore "abandoned this physiological character in dividing the Snakes into families. Poisonous as well as harmless forms are arranged under Colubridæ." The difference between channeled and perforated teeth proves, moreover, to be but one of degree, and the term "perforated" is anatomically incorrect. In both these types the author finds the structure of the teeth essentially the same; they are folded over so as to form a duct to carry the poisonous secretion; when the edges meet and coalesce, a perforated fang is formed; when they merely approach each other, the channeled form results.

The learned author cannot, unfortunately, suggest a criterion by which it might be possible to distinguish at a glance between harmless and poisonous snakes. We wish, however, he had referred to a point which is stil involved in complete darkness. In British India, according to official reports, from 20,000 to 23,000 people die every year from snake-bite (20,067 in 1883; 20,142 in 1885; 22,134 in 1886); whereas in the French possessions in Farther India, and in the Dutch settlements in the Malay Archipelago, and in tropical Southern China, the deaths from this cause do not, in each, exceed ten in the year. Accurate statistics on the subject have been provided, especially by Dutch and German physicians in Java and Hong Kong. As the climatic conditions in all these countries are much the same, and as the frequency of snake-bite is not essentially different in the lands mentioned, and even many of the species (Naja, Bungarus, Trimeresurus) are alike, we have here a problem which has not yet been solved. To the present writer the number of yearly deaths from snake-bite in British India seems to be doubtful, and considerably exaggerated.

About 1500 species of snakes are known. Their systematic arrangement, as is well known, is extremely difficult. Mr. E. D. Cope's recent attempt in this direction[1] was not successful. Zoologists are much more likely to be satisfied with Mr. Boulenger's proposals. He arranges the Ophidia into nine families, viz. Typhlopidæ, Glauconiidæ (Menostomatidæ *olim*), Boidæ (including the Pythoninæ, Chondropythoninæ, and Boinæ) Ilysiidæ (for Ilysia and Cylindrophis), Uropeltidæ, Xenopeltidæ, Colubridæ, Amblycephalidæ, and the poisonous Viperidæ. Of these families and sub-families, those which are for the first time introduced into science are the Chondropythoninæ (Boidæ without præmaxillary teeth, but with a supra-orbital bone) and the Ilysiidæ (snakes with both jaws toothed, with transpalatine and coronoid present; præfrontals forming a suture with

[1] "The Reptiles of British India." By Albert C. L. G. Günther. London: Published for the Ray Society by Robert Hardwicke, 1864. Fol.

[1] "An Analytical Table of the Genera of Snakes." By E. D. Cope. Proc. Amer. Phil. Soc., 1886, pp. 479-499.

nasals; supratemporal small, intercalated in the cranial wall; vestiges of hind limbs), the latter a family which forms a passage from the Boidæ to the Uropeltidæ, agreeing with these in the physiognomy and scaling, with the former in the presence of vestiges of pelvis, whilst the skull is exactly intermediate.

The most interesting part of the book is that in which Mr. Boulenger divides and subdivides the family of Colubridæ. Of this, therefore, we may give a somewhat more detailed account. He divides this large family, containing the bulk of the Ophidia, into three parallel series:—

(1) Aglypha. All the teeth solid, not grooved. Harmless.

(2) Opisthoglypha. One or more of the posterior maxillary teeth grooved. Suspected, or poisonous to a slight degree.

(3) Proteroglypha. Anterior maxillary teeth grooved or perforated. Poisonous.

"In each of these series," says Mr. Boulenger, "we have a more or less perfect repetition of forms, due to adaptation to the various modes of life." Of the series represented in the Indian fauna, the Aglypha include the Colubrinæ and Acrochordina; the Opisthoglypha include the Dipsadinæ and Homalopsinæ; the Proteroglypha include the Elapinæ and Hydrophiinæ, all the former being adapted to terrestrial, all the latter to aquatic life. How deeply classification is affected by the new division here offered by Mr. Boulenger, we may see particularly in his record of the Indian genera of Colubrinæ, which we give, as a specimen, in the natural order:—Calamaria, Xylophis, Trachischium, Blythia, Aspidura, Haplocercus, Lycodon, Hydrophobus, Pseudocyclophis, Polyodontophis, Ablabes, Coronella, Simotes, Oligodon, Lytorhynchus, Zamenis, Zaocys, Coluber, Xenelaphis, Dendrophis, Dendrelaphis, Pseudoxenodon, Tropidonotus, Helicops, and Xenochrophis. Hitherto these genera have been included in the families and sub-families Calamariidæ, Lycodontidæ, Oligodontidæ, Colubridæ (with Coronellinæ, Trimerorhinæ, Colubrinæ, Dryadinæ, and Natricinæ), and Dendrophidæ; at least, therefore, in five different families. In how thorough a way the author has set to work in the limitation of genera also, we see from his combination of the genera Elaphis, Calopeltis, Cynophis, Compsosoma, Spilotes, and Gonyosoma in one great genus Coluber. The green, arboreal species referred to Gonyosoma stand in the same relation to Elaphis and Compsosoma as the green Ablabes (Cyclophis), Dipsas, or Trimeresurus to the other species of those genera. There can be no doubt that the phenomena can be more readily reviewed if these closely related forms are placed in one and the same genus than if genera or even sub-families are assumed, simply because some species have adapted themselves to arboreal or sub-arboreal habits, and have in consequence taken on a green colour. The group Acrochordinæ contains five genera—three with well developed ventral shields, viz. Stoliczkaia, from the Khási Hills; Xenoderma, from Java and Sumatra; and Nothopsis, from the Isthmus of Darien: two without ventrals, viz. Aerochordus, from the Malay Peninsula and Archipelago; and Chersydrus, from India to New Guinea. Mr. Boulenger deals with the Dipsadinæ in the same drastic manner. Of Indian genera, the following are placed by him in this subfamily: Dipsas, Elachistodon, Psammodynastes, Psammophis, Dryophis, and Chrysopelea—genera, therefore, which in the old classification were included in Dipsadidæ, Rhachiodontidæ, Psammophidæ, Dryophidæ, and Dendrophidæ. By devoting more attention than previous investigators to the structure of the skull and the dentition, to the number, form, and length of the teeth, and the form of the pupils, the pholidosis of the head, the structure of the scales, and the colour—to which, however, he does not attribute equal importance as a limiting principle—the author gives, it seems to us, a far better and more comprehensive arrangement than his predecessors. However, it cannot be denied that, satisfactory as the present attempt is, the problem of a systematic division of the *Colubridæ* is still far from being solved.

In the group of sea-snakes, Mr. Boulenger divides more sharply the genera Enhydris, Hydrophis, and Distira. The very differently formed dentition in these genera (in spite of their great resemblance in the form of the head, colour, and mode of life) seems to show that they have sprung from three different terrestrial genera, and that their present resemblances are only the result of their adaptation to their life in the water. Thus Platurus is to be regarded as a Hydrophid which may be traced as a direct descendant of the terrestrial Elapinæ.

Finally, Mr. Boulenger's work enriches science with a considerable number of new genera and species, especially in the sub-order of the Snakes; but space will not permit further reference to details. As the book will be indispensable to every naturalist and every layman who may wish to obtain information about the tropical Indian animal world, the few remarks we have given may suffice. The chief value of a work like this lies in its sharp diagnoses, and in its synoptical tables for genera and species, which enable the observer to determine with confidence the form which may be before him. The fact that the author gives a concise view of geographical distribution, and offers short biological remarks regarding some genera and even species, adds to the scientific importance of the work. For many years this will be the standard book for our knowledge of the Reptiles and Batrachia of India; and its moderate price ought to ensure for it a wide circulation both in India and in Europe. There are still many species about which we know little, and some of Mr. Boulenger's readers ought to be, and no doubt will be, stimulated to provide the desired observations and descriptions. The book should find a place in the luggage of every educated traveller who starts for India.

O. BOETTGER.

EDUCATION IN ALABAMA.

History of Education in Alabama, 1702–1889. By Willis G. Clark. (Washington: Government Printing Office, 1889.)

THIS volume forms one of the admirable series of historical monographs published by the Central Bureau of Education at Washington, and edited under the special supervision of Prof. Herbert Adams, of the Johns Hopkins University at Baltimore. It should be explained that in the United States there is nothing analogous to our Education Department, Congress and

the Federal Government having no control or jurisdiction over schools, and each State and city making its own laws and administrating its own educational funds. But Congress established in 1866 at Washington a Central Bureau for the purpose of collecting and publishing statistics; and this Bureau, under the energetic direction of successive Commissioners, has sought to increase its own public usefulness by publishing from time to time valuable works on the history and philosophy of education, and particularly, as various practical problems have presented themselves relating to technical, musical, or physical education, it has gathered together, in pamphlets or circulars of information, the best testimony and opinion which could be obtained on the several subjects.

Prof. Adams's own contributions to the series, notably his "History of the College of William and Mary," and his "Essay on the Study of History in American Colleges and Universities," have been widely read and esteemed in the States; and among the other works included in the series, those of Dr. Bush on "Education in Florida," of Mr. Jones on "Georgia," and of Messrs. Meriwether and Smith on "North and South Carolina," have told with care and fulness the story of educational progress in the Southern States. The present volume relates to Alabama, and is written by Mr. W. G. Clark, of Mobile, who, as sometime President of the University, and as Chairman of the School Committee of the State, is exceptionally qualified for his task, and has been able, with the help of photographs and statistical tables, to present to the reader, not only an interesting historical sketch, but also a full account of the present organization and resources of education in the State. Many of the details in a book of this kind have necessarily a local and personal interest only. Mingled with them, however, are a few facts which may possess significance for English readers. The chief of these relate to the origin and history of the University, the present provision for scientific and technical training, and the general educational condition of the State.

The University was founded in 1821. The general law of the Union—that in all new States one-sixteenth of the public land shall be set apart for schools—dates from 1785, but it was not applied to the Alabama territory till the Act of 1818, which further provided that one entire township should be reserved for the support of a seminary of higher learning. The prudent administration of this large property would doubtless have secured for the State ample provision for learning in all its several departments; but the early history of the University is a melancholy record of mismanagement and neglect. The lands were unwisely sold, sometimes at 8 dollars per acre, the proceeds of the sale were not well invested, accounts were confused, and financial embarrassment followed. To add to these misfortunes, the University appears to have suffered grievously from frequent outbursts of lawlessness and even rebellion on the part of the students. Though the number scarcely exceeded 100 in its best days, and though the annual "output" of graduates averaged little more than 10, the University seems to have striven hard to keep up a high standard of teaching and scholarship, and has been officered from time to time by distinguished men. One is struck, in looking down the list, by observing that, though the University never professed any creed, or sought to maintain a pronounced religious character, many of its presidents and the majority of its professors appear to have been ministers of religion. It is very characteristic of the republican equality which prevails in the United States in regard to religious sects that in 1830, when the buildings of the University were completed, the offer of the principalship was at first made to a Presbyterian divine; that, on his refusal, Dr. Woods, a Baptist clergyman, accepted the office; and that the inaugural services were held in the Episcopal church, the minister of which, with the Governor of the State, took part in the proceedings. Additional buildings, comprising an observatory and a noble library, were added from time to time, but the war of 1861–65 completely interrupted the work of the University, and for a time well nigh ruined it. All the students enrolled themselves in the Confederate army, and after a disastrous struggle, the issue of which is well known, a body of the Federal cavalry, specially despatched for the purpose, set fire to all the public buildings of the University, and reduced them to smouldering heaps of ashes. The librarian, in the hope of changing the purpose of the commanding officer with reference to the destruction of the library, led him thither, unlocked the doors, and showed him the valuable collection of books. "It is a great pity," said the officer, "but my orders are imperative. But I will save one volume, at any rate, as a memento of the occasion." He entered, and seizing a copy of the Koran, withdrew from the building, and ordered it to be set on fire at once. In this way property valued at 300,000 dollars was hopelessly destroyed. It was not till 1870 that other buildings were completed and the College exercises were regularly resumed. As now constituted, the University includes two general departments, of which the first is academical and the second professional. In the former there are ten different schools—Latin, Greek, English, Modern Languages, Chemistry, Geology and Natural History, Natural Philosophy and Astronomy, Mathematics, Philosophy and History, and Engineering. In the department of professional education there are three schools—international and constitutional law, common and statute law, and equity jurisprudence. The rules of the Supreme Court of Alabama authorize the graduates of this department to practice in all the courts of the State, on simple motion, without further examination. The University also provides a special course of instruction under the heads of military art and science, military law and elementary tactics.

Besides the University, Alabama is provided with a remarkable institution of a technical character, called the Agricultural and Mechanical College. It is situated in the town of Auburn, and is endowed with the proceeds of the sale of 240,000 acres of land. Since its foundation in 1872 it has increased in popularity and usefulness, and has become a school of industrial science or a polytechnic institute. Its departments are agriculture and horticulture, mechanic arts, practical chemistry, physics and mineralogy, botany, engineering and surveying, drawing, and military tactics. In the mechanic arts and practical chemistry, its appliances are particularly excellent. There is a wood department in a large hall, provided with a 25 horse-power engine with indicator, planes, circular saw, band saw, scroll saws.

a buzz planer, twenty work benches, with full set of lathes and carpenters' tools required for instruction. A brick building with two large rooms has been constructed specially for instruction in working iron. One of these is equipped with twelve forges, and tools necessary for a forge department; the other with a cupola furnace, moulding benches, and special tools for use in a foundry. The machine is equipped with eight engine lathes with appropriate tools, and a chipping and filing department is arranged, with benches and vices for twelve students. A five horse-power dynamo furnishes light to the mechanic, art laboratory, and other halls, and it is designed to supply the different laboratories with electricity from this source.

Although there are these signs of enterprise, and although the public school system of the State includes elementary schools, high schools for girls, and normal colleges for teachers, Alabama proves, when its educational statistics are examined, to be one of the most backward States in the Union. The latest returns of the United States Commissioner show that the public schools are open on an average only 79 days in the year, and that the average attendance is only 63 per cent. of the number enrolled. The sum annually expended on education is not large, and amounts only to an average of 4 dollars 17 cents per head on the number of scholars. Of the total school revenue, 20 per cent, is derived from land and real estate, 55 per cent. from State taxation, and 24 per cent. from poll taxes, licenses, and other local imposts. Special provision was made in 1867 establishing separate schools for coloured children, who are numerous and increasing in number in this as in most of the Southern States. The last returns show a total of 212,821 coloured children of school age, of whom 98,919 are enrolled in the public schools set apart for them, while 66,424 are on an average in daily attendance during the school year. The year, however, is one of 67 days only. The average cost to the State of the coloured pupils is 2 dollars 10 cents.

These particulars sufficiently indicate the very exceptional conditions under which education is carried on in one of the most important of the South Central States of America, and will show to any student of the subject how much of interesting material has been accumulated in Mr. Clark's well arranged and well illustrated book.

CHEMISTRY FOR BEGINNERS.

Elementary Systematic Chemistry for the Use of Schools and Colleges. By William Ramsay, Ph.D., F.R.S. (London: J. and A. Churchill, 1891.)

AMONG the large number of text-books of elementary chemistry written for the use of schools, this volume will take its place with the very few that are not specially designed to prepare the student for some examination. It is further to be distinguished as having the classification and order of treatment of the elements based upon their periodic arrangement. The author deserves the thanks of those interested in the matter for making this experiment, whether the result be regarded as successful or otherwise. He states in the preface that he hopes "that the method of treating the subject of chemistry adopted in this short sketch may help to demonstrate the value of its study as a training in classification, and as a means of developing the reasoning powers." Certainly this is desirable, and the volume tends in this direction. We find, for example, the preparation of the elements treated under such headings as "Electrolysis of a Compound," "Decomposition of a Compound by Heat," &c., and there is much advantage in comparing the processes that serve for the isolation of the elements in this manner. But the first aim of a knowledge of chemistry is not to develop the reasoning powers. It is rather to give the student more exact ideas than he would otherwise have of the constitution and properties of matter, and it is important to get into his mind not simply the relationships that substances bear to one another, but a definite idea of each substance and its properties. We think that an inspection of the volume before us will confirm the experience of the past that an elementary text-book does well to aim, above all things, at presenting a distinct, and, as far as may be, complete description of each substance, leaving the classification of methods and reactions to the judgment of the teacher or the ingenuity of the student when it is impossible to include both aspects of the matter. Taking oxygen as an example, we are in the habit of finding a chapter in which the methods that serve for its preparation, and its more important properties are set forth in a connected and convenient manner. But in this volume the directions for the preparation of oxygen occupy a few paragraphs in a chapter entitled "Decomposition of a Compound by Heat," at p. 73, while the properties of oxygen are not described till we get to p. 93. To say the least of it, it would be very inconvenient for a student, after having prepared his oxygen, to busy himself with the preparation of sulphur from pyrites, the preparation of magnesium, aluminium, boron, silicon, hydrogen, several metals, the properties of hydrogen and about seventeen metals, besides boron, carbon, nitrogen, phosphorus, and arsenic, before he comes to a practical investigation of the properties of his oxygen.

The author has endeavoured to treat first of the elements, and subsequently of compounds. But elements and compounds are interdependent, and it is obvious that such a separation is practically impossible. We think it is unwise to attempt it, unless, indeed, chemistry is to be degraded into a mere "means of developing the reasoning powers." If education is for this purpose only, the student of a foreign language would do well to devote himself entirely to its grammar, and leave the vocabulary for those who desire knowledge for its own sake.

The difficulty of finding a good beginning place in the teaching of any science has been obvious to all those who have undertaken the task. If children are to be taught, they must be led by slow degrees from what they know to an expanded and fuller knowledge of the matters they are already acquainted with, and so onwards. The periodic law is beyond the grasp of a young student, and the only valid reason that should allow his course of work to be guided by it would be that the subject was thereby rendered more agreeable or more intelligible to him. It does not appear that the periodic law will be able to fulfil this new function.

Looking at the book more in detail, we notice that 60 pages are devoted to chemical physics, 144 pages to

inorganic chemistry, and 141 to organic chemistry. The student who is already fairly acquainted with the subject will find the summaries of properties, &c., of much use. The analogous compounds of various groups of elements are treated together, and their differences are concisely remarked upon. He will, perhaps, be a little troubled at first to find names employed in an unusual manner. For instance, Ag_2O is called argentous oxide; AgO, argentic oxide; AgCl, AgBr, silver chloride, &c.; and there is a statement that "no *argentic* halides are known." If he looks up the paragraph on valency, he will find silver put down as a monad along with hydrogen, potassium, &c., and not with copper and mercury, which are marked monad and dyad. There are other inconsistencies that might have been eliminated, such as in the use of the words distill, and sublime. Directions are given to distill a fluoride with strong sulphuric acid, to distill a mixture of sand, fluor-spar, and sulphuric acid, and so on, and on turning to the description of the operation of distillation, in the first part of the book, we find that the word is used there in its correct sense. The solution of a carbonate in an acid is spoken of, and the sublimation of a mixture of mercuric sulphate and salt. Such operations are impossible according to the meaning of the words expressing them given in the earlier part of the work. The statement that chlorine peroxide is formed by distilling a chlorate with sulphuric acid at a low temperature might lead to serious accidents in the case of the young students for whom the volume is primarily intended. While the symbol Aq. is used to represent the water of solution, a refinement which is scarcely necessary in an elementary treatise, the reaction taking place when a jar of chlorine is inverted over a strong solution of ammonia is represented by an equation that demonstrates the liberation of hydrochloric acid. It is such inconsistencies as these that perplex and mislead the student.

C. J.

OUR BOOK SHELF.

Applied Geography. By J. Scott Keltie. (London: George Philip and Son, 1890.)

THE greater part of this volume consists of four lectures which were delivered last year at the Bankers' Institute, and given in part before the Society of Arts and the College of Preceptors. An article which appeared originally in the *Contemporary Review* is also included. The volume is one of great interest, both theoretical and practical, and ought to be of genuine service to various classes of readers, by showing how high is the place which must properly belong to geography in any complete scheme of education. Mr. Keltie has been especially successful in indicating some of the influences which geographical facts have exerted on the movements of races and the evolution of nations. On so great a subject it was impossible for him, within narrow limits, to develop any of his ideas fully; but his suggestions are excellent, and may perhaps be worked out by some of his readers for themselves. Mr. Keltie has much to say about the bearings of geographical conditions on the development of Africa, and about the relation of geography to the commercial prosperity of the British Empire. He also discusses various problems connected with the actual and possible geographical distribution of some of the common commodities of commerce. On all these subjects he writes with freshness and lucidity, displaying a thorough grasp of the principles of geographical science. Maps and diagrams, for which the author expresses his thanks to Mr. Ravenstein, add considerably to the value of the text.

The Autobiography of the Earth. By the Rev. H. N. Hutchinson, B.A., F.G.S. Pp. 290. (London: Edward Stanford, 1890.)

WE have rarely met with a popular work on geology or natural history so crowded with information as Mr. Hutchinson's little volume now before us. In less than 300 pages of large type, all the leading features of the "geological record" are passed in review, with special reference to the mode of reasoning by which the various facts and inferences are established. Nothing of importance seems to be omitted, from the nebular hypothesis and the birth of the moon, to theories of glacial epochs, the permanence of ocean basins, the origin of oolitic structure, and the method of discovering the hidden appendages of trilobites. Some of the sections, indeed, such as those relating to the nebular theory and the nature of geological agents, are seldom found more concisely arranged even in the pages of an examination "cram-book."

With all this wealth of material, however, the author succeeds in completely divesting his work of the "dry" and "uninteresting" formality which, in his opinion, repels the general reader from ordinary text-books. The several chapters are pleasantly written and illustrated with occasional woodcuts; while, although the accounts of the successive formations are systematically arranged from the Archæan to the Pleistocene, every occasion that permits of some digression into general principles is turned to good advantage An allusion to the igneous rocks of the Devonian period thus leads to a few brief paragraphs on the interest of denuded volcanoes; the Lower Carboniferous rocks afford an opportunity for discussing the origin of limestones; the chapter on the Oolitic rocks is followed by another on the organization of Mesozoic reptiles; and the short notice of the Glacial period forms a fitting occasion for digressing to the subject of ice as a geological agent. If, in any respect, the general reader's interest fails, it will be due to the too frequent use of inadequately defined technical terms, and the too rapid succession of unfamiliar ideas. Of such terms as "schist" and "Neocomian," for example, the definition seems to have been quite overlooked.

In a compilation of so wide a scope it is, of course, easy for a specialist to detect inaccuracies, but the present volume bears evidence of so much care bestowed in its preparation, that absolute errors appear to be unusually few. The bold statement on an early page that glaciers erode valleys like rivers is qualified in the last chapter; and the assertion that no Chelonian bones have been found in the Trias is corrected in a footnote on a later page. The most serious error is the frequent quotation of brachiopods and polyzoa as Mollusca; and nearly all the lesser misstatements relate to biological matters. The author, however, unlike many popular writers, has been trained in the modern school, and thus recognizes throughout the broad principles of organic evolution.

The volume is well printed, and issued in a style uniform with Miss Arabella Buckley's popular works, to which it forms a worthy companion.

A. S. W.

Spinning Tops. "Romance of Science Series." By Prof. John Perry, F.R.S. (London: Society for Promoting Christian Knowledge, 1890.)

IN September last Prof. Perry delivered the "Operatives' Lecture" of the British Association meeting held at Leeds, the subject of which was entitled "Spinning Tops." The present little work is a revised and much expanded edition of that lecture, and, instead of the moving apparatus originally displayed, the author has provided a

very approximate equivalent in the elaborate illustrations and descriptions. He begins by showing the rigidity of flexible bodies when in motion: he then describes the behaviour of a common top by means of a balanced gyrostat, and explains the importance of giving a rotary motion to projectiles. The gymbal gyroscope and the curious movements that are connected with it are afterwards discussed, and the analogy of these movements to that of the earth in regard to precession, &c., is pointed out.

The next point referred to is the importance of balancing a rotating body, the author showing that for perfect balance not only must the axis of rotation pass through the centre of mass of the body, but it must be one of the three principal axes through the centre of mass of that body. Reference is made to the experiments of Prof. Milne, who has shown, by means of a modified seismograph, the want of balance in the wheels of locomotives.

In the last few pages Prof. Perry deals with the connection between light and magnetism and the behaviour of spinning tops, and among the experiments is Thomson's mechanical illustration of Faraday's rotation of the plane of polarization, which is performed by means of a number of double gyrostats placed in a line and connected by india-rubber joints, each instrument being supported at its centre of gravity, and capable of rotation in the horizontal and vertical planes. To many readers the book will be one of great interest, and a brief summary at the end will show them clearly the line of argument adopted throughout.

Wild Life on a Tidal Water. By P. H. Emerson. (London: Sampson Low, 1890.)

IT seems rather odd that an author should talk about "wild life" when he means simply life on a house-boat on Breydon Water in Norfolk. No one, however, who glances over the present volume will be disposed to criticize the title very severely, for Mr. Emerson has the art of describing even unimportant things in a way that makes them interesting. Above all, he has provided a series of thirty admirable "photo-etchings," which convey a wonderfully vivid impression of the various scenes reproduced. The photographic plates were taken by Mr. Emerson himself, but in selection of subject the majority are the result of a pleasant partnership with his friend Mr. T. F. Goodall, on whose house-boat he experienced the trials and delights of "wild life."

Arcana Fairfaxiana. With an Introduction by George Weddell. (Newcastle-on-Tyne: Mawson, Swan, and Morgan, 1890.)

THE manuscript of which a facsimile is presented in this volume was found some years ago by Mr. Weddell in a box of lumber. It contains much apothecaries' lore and housewifery dating from the first half of the seventeenth century, and was used, and partly written, by the Fairfax family. In a carefully-written introduction Mr. Weddell gives all necessary information about his treasure and about the persons with whom it has been associated. The facsimile is skilfully printed, and many of the medical receipts, and some of the instructions as to the baking of meats, are very curious and interesting.

Berge's Complete Natural History. Edited by R. F. Crawford. (London: Dean and Son, 1890.)

IN this volume some of the leading facts relating to the animal, the vegetable, and the mineral kingdoms are brought together. The descriptions, if not very interesting, are clear, and the reader is helped to understand them by means of no fewer than sixteen coloured plates, and over three hundred smaller illustrations.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Bursting of a Pressure-Gauge.

WITH reference to Mr. Smith's letter in your issue of February 5 (p. 318) respecting the bursting of a pressure-gauge, will you allow us to point out a very simple method of preventing any serious consequences from such an accident, which must occasionally occur as the gauges wear out? There should be no cast-iron in the gauge: the tube and works should be mounted on a brass or gun-metal frame. The glass covering the dial should be mounted in a ring, fitting on the body of the gauge like a cap; when the gauge is in use this cap should be removed, thus avoiding all danger from the broken pieces of glass. The gauge should then be inclosed in a brass wire cage, so that, should the tube burst, any portions of metal would be caught by the wire network, and, if not stopped altogether, would at any rate be rendered harmless.

Our *employés* are constantly using gauges for testing gas bottles, and we have always had our gauges made in this way to avoid any risk from accident. The screw valve of the bottle should not be turned on full, one complete revolution of the screw is quite sufficient; this greatly minimizes the risk of fusion caused by friction, as the cylinder would probably take a quarter of an hour to empty itself. Of course the same gauge should never be used for both oxygen and hydrogen cylinders.

3 Fleet Street, February 11. NEWTON AND CO.

Modern Views of Electricity.

(1) THE first question that I raised in my former letter was how oxygen atoms come by the negative electricity which according to Dr. Lodge they have. I find in his pamphlet, "Seat of E.M.F." (p. 50), his view stated as follows, that whatever may be the case with molecules of oxygen, at least all dissociated atoms have a certain definite negative charge. If this be so, it seems to me to follow necessarily either that all molecules of oxygen are negatively charged, or that only those which are so charged can undergo dissociation.

(2) We are then to suppose a crowd of dissociated atoms of oxygen, all having negative electrification, "straining at," *i.e.* attracted by, the zinc. And this attraction, we are told (p. 50), exists independently of actual combination between zinc and oxygen, although it has its origin in the desire for such combination. It is a mechanical force arising from chemical affinity. Such a force would, according to the kinetic theory of gases, increase the density, and therefore the pressure, of oxygen in the neighbourhood of the zinc, causing a repulsive force, in addition, as it seems to me, to the repulsion due to like electrical charges. By this means the state of the gas in the neighbourhood of the isolated zinc would become one of equilibrium. And it may be that the variations of density would take place only within a distance from the zinc too small for our means of measurement. According to the statement (p. 110) of "Modern Views," only the repulsive forces arising from electrification are relied upon as producing equilibrium. I think, however, that Dr. Lodge would not exclude other mutual repulsive forces which may exist between the dissociated atoms of oxygen. And such other forces appear to me to be necessary, in order to explain satisfactorily the phenomena which ensue when the zinc is brought into contact with copper.

(3) When contact is made, a positive charge passes from the copper to the zinc. Let us call it σ per unit of surface. That disturbs the equilibrium previously attained about the zinc, because it introduces a new force of attraction on the oxygen atoms in virtue of their negative electrification. This force will be $2\pi\sigma$ per unit of surface. In order that there may again be equilibrium, we must introduce a counteracting force $-2\pi\sigma$. Now the new attractive force calls in a fresh influx of oxygen atoms, increasing their density, and therefore increasing the negative charges per unit of surface of zinc. If we had no repulsive forces, except those arising from electrification, the charges on these newly imported atoms would, I think, have to be $-\sigma$ per unit of area of the zinc, in order to give the required force $-2\pi\sigma$. This would exactly neutralize the positive charge

$+\sigma$ derived from the copper, and so would reduce the zinc to its original potential. Under these circumstances statical equilibrium could, as it appears to me, never be attained. But if there exist repulsive forces between dissociated atoms of oxygen other than those due to their negative electrification, we may obtain our repulsive force $-2\pi\sigma$ without introducing so many atoms as that their negative charges, referred to unit of surface of the zinc, shall be $-\sigma$. It may be $-\sigma'$, where σ' is less in absolute value than σ. And so we should, on making contact with copper, obtain a total charge on the zinc $\sigma-\sigma'$ per unit of surface. This is positive. The zinc may then be raised to the same potential with the copper, and at the same time the attractive and repulsive forces on dissociated oxygen atoms near the zinc may be in equilibrium. So it seems to me that, assuming the electrification of oxygen and its attraction by the zinc to be as stated by Dr. Lodge, the theory consistently explains phenomena up to this point, and may explain also the variations due to moisture of the zinc or other conditions.

(4) As regards the "intrinsic step" of potential relied upon by Dr. Lodge to explain the aluminium needle experiment, I cannot so easily follow him. Consider the surface of the isolated zinc, and let C be a point just so distant from it that the potential at C is sensibly unaffected by the presence of the zinc with its negative charges, and those of its attendant oxygen atoms. C is then at zero potential, that of the zinc being -1.8. Intermediate points are at intermediate potentials. When, on making contact, you introduce the positive electricity from the copper, you raise the potential of the zinc by half a volt. But the potential at C is, *primâ facie* at all events, no more affected by the positive than it was by the original negative electrification of the zinc, and remains zero. You have diminished the "step" by half a volt. As before, intermediate points would have intermediate potentials. In fact, so far as the potential at C is concerned, may we not suppose the newly introduced positive electricity simply to neutralize an equal quantity of the negative electricity previously found on the zinc?

S. H. BURBURY.

ON this head I would say that a point outside the surface-film, beyond the molecular range, is naturally unaffected by the chemical affinities of the surface; but it is by no means therefore uninfluenced by the ordinary dielectric strain of a static charge imparted to the zinc in any adventitious manner. Such a charge alters the potential of the whole neighbourhood, but does not alter the slope of potential existing in the surface-film. Nothing can alter that but a modification of the surface or of the adjacent medium.

Thus I state my position briefly in order that the sole remaining divergence of view between Mr. Burbury and myself may likewise disappear.

OLIVER J. LODGE.

PERHAPS the following slight elaboration of Dr. Lodge's views on the electrical condition of air films in contact with metals will commend itself to Mr. Burbury. It seems to me that by its means the difficulty of realizing the source of the negative charge on the oxygen atoms is to a certain extent got over without thereby forfeiting any of the essential features of the air film theory.

Assuming the truth of this theory, the fact to be explained is that when clean zinc is put into pure oxygen it becomes coated with a film of that substance which is at a higher potential than the zinc by 1.8 volt.

If the film be regarded as a conductor, this step of potential has to be brought about in the first instance by combination of a few zinc atoms with oxygen, so that the film becomes coated with + electricity on both its surfaces; the field set up by this and a corresponding − charge on the surface of the metal underneath representing the 1.8 volt step of potential between the two. It is at this point that the difficulty of the − charge on the oxygen atoms arises, as they have just been assumed to be +; and, also, this other smaller difficulty, that the + and − charges on the opposed film and metal surfaces, corresponding to 1.8 volt and at molecular distance apart, are such that every atom in each surface is charged with a quantity of electricity which is of the same order of magnitude as its electrolytic charge; a fact which necessitates the previous combination of every atom in the zinc surface with oxygen from the film if the ordinary laws of electrolysis are to be assumed; whereas according to the film theory, wholesale oxidation of the metal surface destroys the Volta effect altogether.

If, however, the film be regarded as a non-conductor, both these difficulties vanish.

The molecules which form the film would be gaseous except for the presence of the metal. The latter holds them to itself, and may be looked upon as, in a sense, polarizing them into chains or rows normal to its own surface. Supposing such chains to consist each of what were originally three distinct diatomic gas molecules, A_1A_2, B_1B_2, C_1C_2, with a metal atom M next to A_1, there will be a tendency to combination between A_1 and M, which will slacken the

$$M-A_1\equiv A_2-B_1\equiv B_2-C_1\equiv C_2-$$

bonds between A_1 and A_2, leaving A_2 partially free to hold on to B_1, which again will promote a holding on between B_2 and C_1, so that C_2 is partially uncombined. The bonds between A_2 and B_1, B_2 and C_1, represent in fact the cohesion of the film (or part of it), and are the result simply of the tendency to combination between M and A_1. If this be very great, actual combination may occur, which will set free A_2B_1 and B_2C_1 as gas molecules, leaving C_2 to find another partner. On the other hand, the tendency to combination between M and A_1 may be too small to do more than polarize the molecules, and this is perhaps what occurs with zinc in dry oxygen.

If, now, the essence of combination between zinc and oxygen is that the zinc atom is + and the oxygen −, we may assume, without entering on ultimate problems, that the row of molecules is polarized *electrically* as well as mechanically. $A_1B_1C_1$ all −; and $MA_2B_2C_2$ +; so that the film may be looked on as a dielectric plate, with a coating of metal on one side only, and a + charge on the other. The slope of potential between film and metal (*i.e.* the Volta effect) occurs now, not between their surfaces of contact, but right through the film, the 1.8 volt existing between the *outside* surface of the latter and the metal. No actual chemical combination is necessary to bring it about; and, indeed, any combination at all is prevented by the internal affinities in the film itself just described.

A. P. CHATTOCK.

University College, Bristol.

Pectination.

REFERRING to Mr. E. B. Titchener's letters in NATURE (see December 4, p. 103, and January 15, p. 248), I am able to confirm the view that pectinated claws are used by the birds possessing them for the purpose of scratching themselves.

On December 9 last I shot a cormorant, and found the fissures between the teeth of one of its pectinated claws choked up with fragments of down. This down corresponds with the bird's own down, and there can be little doubt that it is the bird's own down, and that it became thus situated through the claw being used for the above-mentioned purpose. I may also mention that I have since found minute fragments of feather in the claw of a barn owl.

Many birds use the middle claw to scratch themselves with, as Mr. Titchener remarks; and this claw appears to be very generally modified for the purpose. The modification consists in this, that the inner edge of the claw is bent out, and developed into a curved blade running along the inner side of the claw. Such a blade is well developed in guillemots and razorbills. It may also be easily seen in wild duck, teal, gulls (some at any rate), oyster catchers, golden plover, starlings, fieldfares, redwings, larks, and many others. In some birds the modification is very slight, but in all I have been able to examine (not an extensive collection) it seems to exist in some degree. In the divers, the claws are so flattened that the inner edge naturally forms a scraper, and the same may be said of other birds, such as partridges and pheasants.

Pectination is only a further modification of this blade, or inner edge of the claw, in that it becomes divided up by notches or fissures, placed at more or less regular intervals, into a comb-like structure. As is known, the middle claw is not pectinated in young nightjars. I have now in my possession a young, though almost full-grown male of this bird, and it has the middle claw provided with a well-developed blade, but there is no trace of pectination. I may mention too, that I have found the edge of the blade in a guillemot, slightly indented here and there, thus offering an approach, though but a very distant one, towards pectination.

The pectinated claw, then, should not be regarded as a structure

peculiar to nightjars, owls, herons, cormorants, and gannets, and different from anything found in any other bird, but merely as a highly modified form of a structure found in a less modified form in many birds. Presumably these structures serve to rid the birds of troublesome parasites. If this is correct, it would be interesting to learn whether the birds possessed of pectinated claws are particularly liable to the attacks of hurtful parasites, or whether we may consider that in them only have variations in the direction of pectination arisen.

Treborth, Bangor, January 24. H. R. DAVIES.

MR. DAVIES' confirmation of my results is very interesting, and in many ways, I think, conclusive. So far as my memory serves me (I have not here access to a collection), I can bear out all his facts. I regret that I have never taken the names of the different species in which I have observed the blade. The Pomarine Skua is one. A friend tells me that he has also noticed a jagged blade ; and, he believes, in a guillemot.

It would appear that the list of pectinated birds given by Owen ("Anat. and Physiol. of Vertebrates," ii. 232) is too short. Indeed, we may hope to find many links between the blade and the serration. Mr. F. E. Beddard, in a paper on *Photodilus badius*—an owl considered by some ornithologists to be very near *Strix* (*Ibis*, 1890)—writes : "The claw is, however, produced laterally into a knife-edge, as in other owls. . . . I have examined an example of *Strix*, in which the jagged edge of the toe in question was very inconspicuous ; and the question arises, whether it does not occasionally disappear altogether."

As regards the question of vermin, Owen says that each species of pectinated bird is infested by its peculiar louse (*Nirmus*). According to Hudson, the herons are especially free from vermin ;[1] though the (roseate) spoonbill, which also has the pectination, is infested with them ("Argentine Ornithology," ii.). This author does not think that the herons could ever rid the entire plumage of vermin by means of the claw. It is curious that the herons were always in a miserable condition ; the spoonbills plump and healthy.

Audubon once shot a frigate-bird which was scratching its head ; and, on examining the pectination with a glass, found the racks of the comb crammed with the insects which occur on the bird's head, and especially about the ears. He also observed that the pectinated claws of birds of this kind were much longer, flatter, and more comb-like than those of any other species with which he was acquainted. He gives the tropic-bird (also a *Steganopod*) as having a knife-edge.

I am unable to say whether certain members of a genus are, as a rule, more infested by vermin than others.

E. B. TITCHENER.

Inselstrasse 13, Leipzig, February 11.

On the Affinities of Hesperornis.

IN Dr. Shufeldt's letter (NATURE, Dec. 25, 1890, p. 176) no mention whatever is made of Prof. Fürbringer's studies on the point in question, and they appear, moreover, to have been partially misunderstood by Prof. Thompson. Prof. Fürbringer published his "Untersuchungen zur Morphologie und Systematik der Vögel" (2 vols. in folio ; Amsterdam) in May 1888, and I beg to reproduce some of his results as to the family *Hesperornithidæ*.

Like Prof. Marsh, Prof. Fürbringer sees Ratite characters in the configuration of sternum, breast-girdle, and anterior extremity, but, in opposition to that author, finds nothing of a specifically Ratite description in the remaining parts of the skeleton. On the other hand, these parts—especially the pelvis and hinder extremity—correspond, as shown in detail, decidedly with the type *Colymbidæ*, *Podicipidæ*, and *Enaliornithidæ*. Herein lies the clue to the systematic position of *Hesperornis*.

Particular attention has, further, been paid to the dentition, on account of which Prof. Marsh has grouped under the S.C. *Odontornithes* the *Hesperornithidæ*, as O. *Odontolcæ*, with the *Ichthyornithidæ* (O. *Odontotormæ*), and with the *Archæopterygidæ* (O. *Saururæ*). In this Prof. Fürbringer does not follow him, but maintains that, in all probability, all ancestral ornithological forms possessed toothed jaws, and, consequently, that the dentition is of as little decisive genealogical importance in birds as in mammals, and that the three orders of toothed birds mentioned belong to completely different ornithological types, of which the Ratite *Hesperornithes* stand much nearer to the *Colymbo-Podicipites*, and the Carinate *Ichthyornithes* to the *Laro-Limicolæ*, than they do to one another.

The condition of the sternum, however, whether Ratite or Carinate, may not afford a point of more weighty genealogical significance. According to Prof. Fürbringer, the better-known *Ratitæ* form a perfectly artificial group—a medley of once Carinate birds sprung from the most dissimilar genealogical branches, which now possess nothing in common further than the purely secondary point of analogy that, with the advancing development of the hind-limb and increasing bulk, they have lost the power of flight. The representative forms of the so-named S.C. *Ratitæ* are as far, if not further, removed from one another, as are those of the S.C. *Carinatæ*, though, between this or that division of either S.C., certain points of affinity of a non-intimate nature are to be found. These are closely examined in Prof. Fürbringer's work.

After having set aside the higher taxonomic significance of the dental and sternal characters, there remains for Prof. Fürbringer only the decided agreement of the skeleton of the *Hesperornithidæ* with that of the *Colymbidæ*, *Podicipidæ*, and *Enaliornithidæ* as of true genealogical worth. The relations of these divisions are of a truly genetic description, but it is impossible to derive the *Colymbo-Podicipites* from the *Hesperornithes*, which were differentiated already in the Cretaceous period in the most one-sided manner. We might with better right trace the latter to some very ancient *Colymbo-Podicipite* form, though the safest course to follow is to regard both as independent branches of a common bough.

The avian system drawn up in chapter vi of Prof. Fürbringer's work, and represented in the accompanying genealogical trees (Plates xxvii.-xxx.), is based upon these considerations. Neither *Odontornithes* and *Anodontornithes* (*Euornithes*), nor *Ratitæ* (*Platycoracoideæ*) and *Carinatæ* (*Acrocoracoideæ*), are mentioned as genealogical divisions, but a S.O. *Podicipitiformes* is formed out of the *gentes Enaliornithes* (F. *Enaliornithidæ*), *Hesperornithes* (F. *Hesperornithidæ*), and *Colymbo-Podicipites* (F. *Colymbidæ* and F. *Podicipitidæ*).

All this proves that the penetrative researches and observations of Prof. Fürbringer on the position of *Hesperornis* had raised him no less than two and a half years ago in the chief question to the point attained by Prof. Thompson and Dr. Shufeldt in 1890. The latter writers differ from him only in that Prof. Thompson ascribes to *Hesperornis* as intimate a relationship to the *Colymbi* as, for instance, that of *Stringops* to the *Psittaci* ; while Dr. Shufeldt holds it possible that the *Colymbi* are descended from *Hesperornis*. As is shown in a recent paper on the subject (cf. *Ornitholog. Monatschr. d. Deutsch. Ver. z. Schutze d. Vogelwelt*, 1890, No. 18), Prof. Fürbringer is unable to share these taxonomic views, but abides by the opinion maintained by him in 1888. F. HELM.

Royal Zoological Museum, Dresden, January 29.

Destruction of Fish by Frost.

I THINK it follows from the second clause in the question at the end of my letter of January 26 (p. 295) that I assume want of air to be the cause of the destruction of the fish in the Regent's Canal. Cases like that which Mr. Hill mentions (p. 345) have been so familiar to me from boyhood that it did not occur to me to be more explicit. Moreover, I did not say that the effect of this agent of destruction would often be "on a scale visible to the geological eye." This it is of which I was thinking : occasionally fossil fish are very numerous in a particular stratum. Various causes for this apparently sudden destruction have been suggested ; it occurred to me that this one sometimes might have to be considered among the possible contingencies. Though, as he says, a slight flow of fresh water is "seldom wanting in any natural body of water," yet fish may be killed (as I have seen) in a pond through which a streamlet runs. The supply must be equal to the demand. Now the volume of streams in certain cases is greatly reduced in winter : the Reuss above Wasen on November 28, 1889, was a very different river from that which we have seen in summer. If, then, a lake were frozen, and the amount of water which entered it greatly reduced, the conditions of a pond might possibly be imitated during an exceptionally long winter, or even a river become almost like a canal. This remark applies especially to freshwater deposits, but as long frosts are sometimes followed by floods, the dead fish might be carried for a considerable distance. T. G. BONNEY.

[1] The fact that my bird scratched himself immediately after a meal may be in point here.

BABYLONIAN ASTRONOMY AND CHRONOLOGY.

BABYLONIAN astronomy has been investigated during the last year successfully by the Rev. Joseph Epping and the Rev. J. N. Strassmaier, S.J., who have explained and annotated two Babylonian calendars of the years 123 B.C. and 111 B.C. in their publication "Astronomisches aus Babylon oder das Wissen der Chaldæer über den gestirnten Himmel" (Freiburg, Herder, 1889). They have succeeded in giving a satisfactory account of the Babylonian calculation of the new and full moon, and have for the first time identified by calculations the Babylonian names of the planets, and of the 12 zodiacal signs and twenty-eight normal stars which correspond to some extent to the 28 *nakshatras* of the Hindoos. In the following passages, translated from their book, we give the general results they have obtained, but for many interesting details we must refer the reader to the work itself.

Astronomical Summary.

In discussing the condition of the astronomy of the Babylonians we must rely upon the wider knowledge which we have now attained in regard to their acquaintance with celestial bodies. In this respect the Cuneiform Inscriptions before us furnish much that is new: other already more familiar material is confirmed through them and receives a documentary foundation. Before entering into details it will be well to call to mind how much of the Babylonian astronomy was previously historically established. The reader need not fear that we shall lay before him one by one the conclusions of authors who have written about the Babylonians with more or less trustworthiness, or that we shall subject their works to the light of criticism; we are fortunately spared this trouble. Rudolf Wolf, utilizing all sources bearing upon the subject, has made the most thorough studies, and has accomplished the task in so satisfactory a manner in his well-known "History of Astronomy,"[1] that we may accept his judgment with the fullest confidence. He sums up his opinion of the Babylonians shortly in the following words: "It is beyond doubt that, as early as the time of the philosopher Thales, the Chinese and Babylonians possessed observations extending over several centuries of the most striking celestial phenomena, and that through them their attention had been directed to the periodical return of corresponding eclipses after a cycle of 223 moons, or 18 years and 11 days, which they called Saros, and employed for making predictions." In the discussion of the "Most ancient views upon the system of the world" (p. 23) he says further: "While the Babylonians, Chinese, and Egyptians contented themselves with collecting isolated experiences, fixing certain periods, &c., and scarcely a trace of any scientific system whatever is to be found in their work, the ancient Greeks struck out an entirely different line."

Speaking of the Metonic cycle, a period of nineteen years, at the expiration of which the lunar phases return partially to the same hour, but sometimes with a difference of twelve hours, Wolf mentions indeed the Indians and Chinese, but not the Babylonians; to the latter he simply denies the knowledge of precession, and the difference between the sidereal and tropical years. The same scholar says, referring to the Zodiac[2]:—"To which ancient people the priority in this respect belongs, whether to Indians, Chaldæans, Chinese, or Egyptians, &c., we are to this hour ignorant, in spite of all that has been suggested, and of very extensive researches; and we shall perhaps never know, since all dates are too uncertain, and all representations too crude and inexact; and we are equally far from ascertaining from which people this knowledge, even though with some transformation, passed over to the Greeks. The Zodiac was certainly not invented by the Greeks, who at first possessed only eleven signs because, through a misunderstanding of what came to them from abroad, they threw Libra and the claws of Scorpio together." R. Wolf's work records nothing of the knowledge of the Babylonians about the courses of the planets; the scanty mention of them is too obscure and general.

So far the Cuneiform Inscriptions have not lifted the veil of darkness, but in one direction, with respect to observations, they have brought greater clearness. According to Dr. Kaulen,[1] the Babylonians had numerous observatories throughout the country which were specially fitted up for watching, and the observations must have been made regularly, for the astronomers had to send in their records at appointed times. Dr. Oppert[2] has examined and interpreted several astronomical reports of the Assyrians, and a few passages from one of them (the text is published in Rawlinson's "Cuneiform Inscriptions," vol. iii. plate 59, n. 9) are given here:—

"To the King, my lord, thy faithful servant, Mar-Istar."

"On the 27th day the moon disappeared. On the 28th, 29th, and 30th days we observed the moon's node of the eclipse of the sun: the time passed by: no eclipse occurred."

"On the first day, as the new moon's day of the month Thammuz declined, the moon was again visible over the planet Mercury, as I had already predicted to my master the King. I erred not."

"In the hour (kaš-su-ut) of Anu (Saturn[3]) she appeared at setting, in the circle of Regulus (chief of the heavenly host), but her track was not discernible in the mist of the horizon."

Even if observations of this kind were intended to serve astrological ends, they must also have helped to prepare the ground for astronomy, and that this ground was really trodden by the Chaldæans we have strong evidence in the tables which we have interpreted.

Before considering this point more closely, it might be well to answer the question, When does the recognition of a succession of natural phenomena become scientific?

Regular observation, with its corresponding record of such phenomena, certainly belongs to science, yet is not science in itself, but merely the necessary primary condition: science only begins when amongst these various forms the natural law comes to light. If the law discovered have such a firm and fixed form that it can be submitted, as it were, to a practical test, we have then to record a truly scientific victory. This practical test can, as a rule, be conducted in various ways according to the nature of the phenomena. If we are in a position to call into existence the conditions on which these phenomena depend, although on a smaller scale, then the law which has been discovered may be experimentally verified. Of course we must renounce the idea of experiment with regard to our celestial phenomena; but in its place another no less certain method is at our command. For instance, if the law of a planet's motion be discovered and completely ascertained, it must be possible to determine beforehand whereabouts in the ecliptic that planet will be found on a certain day.

We learn that the Babylonians applied these tests, and, considering the period, they accomplished them in a brilliant manner. With regard to the moon they were able to declare, not only the day of crescent moon, but also the time of her visibility on that evening, as well as the duration of visibility on the day of her disappearance. Their data for the risings and settings of the full moon are most satisfactory. As to eclipses, they did not con-

[1] "Geschichte der Wissenschaften in Deutschland: Neuere Zeit. Geschichte der Astronomie," von Rudolf Wolf (Munich, 1877).
[2] *l.c.*, p. 188.

[1] *l.c.*, p. 172.
[2] "Die astronomischen Angaben der assyrischen Keilinschriften," von J. Oppert (1885).
[3] Dr. Oppert takes Anu for Saturn; we have proved that *An* is Mars.

fine themselves to their so-called Chaldæan period, for through this alone it would have been impossible to give the real visibility of an eclipse of the moon[1]; but the Babylonians determined the visibility, the hour, and the magnitude of the eclipse. They only once decidedly failed, when they announced an eclipse which never happened, or would certainly not have been visible in Babylon. Here, however, we may raise the question whether this failure should be attributed to the method employed or to an accidental miscalculation. The latter is the most likely, as in other data they are only guilty of comparatively small errors. They were well up in the paths of the planets. Their data for the heliacal risings and settings, for opposition, retrogression, and especially for the position of certain fixed stars, are within a few degrees of the reality. We can produce nothing similar from any other people of antiquity. We must, therefore, not neglect to rectify an error which, since the time of Biot, has appeared in books of history.

R. Wolf also says in his "History,"[2] speaking of stellar co-ordinates:—"Even the ancient Chinese must have observed the culmination times of the stars by the help of their water-clocks, and, according to Biot, 28 stars distributed in the circle of the heavens (*i.e.*, in the ecliptic) served their purpose: they compared these stars again and again with each other as firm points of reference from which to determine the positions of the remaining stars, and especially of the planets. By the help of this practice—unchanged from time immemorial—they derived the periods of revolution of the sun, the moon, and the planets with great accuracy, ascertained the periods which bring these bodies into conjunction with, or opposition to, each other, &c. On the other hand, the Chaldeans, like the ancient Greeks, observed the horizon almost exclusively."

It was not the Chinese but the Chaldæans to whom the whole merit should have been given in the above quotation, and they have further the credit of having erected for themselves, with the help of these normal stars, a scientific edifice of astronomy which suggested to them the means of announcing, for future times also, the places of the planets almost to a day. It is remarkable that here exactly 28 normal stars are spoken of, a number corresponding to their 28 constellations; yet it is unlikely that the Babylonians should not have also selected one or another star in the neighbourhood of the ecliptic, in Aquarius, or in the beginning of Pisces, even if of lesser magnitude, the more so as they made use of all twelve signs of the Zodiac for determining the positions of the planets at their heliacal rising and setting.

It might appear striking that the observations of the sun are scanty, and that even the direct ones appear somewhat faulty. As an instance, the autumnal equinox is correct with regard to the position of the sun, while the vernal equinox and the summer and winter solstices are not correctly indicated astronomically. We have already remarked that this deviation was probably intentional, in order to divide the year into equal parts. Moreover, the Chaldæans must have been very familiar with the path of the sun, since that was the first condition of being able to indicate accurately, as they did, the constellations for the planets and the Sirius phenomena. These two tables do not admit of any positive conclusions as to the accurate knowledge of the tropical year and the difference between it and the sidereal year, or of the retrogression of the vernal point: we ought to possess others more remote by some centuries than the above-mentioned ones.

Though we may only answer it by conjecture, we cannot dismiss the question which forces itself upon us here—namely, How did the Babylonians contrive to foretell the positions of the moon and the planets? They must have had some sort of theory concerning the movement of the moon, for we find a completely developed mechanism of calculation through which they developed the new moon from the preceding one, so that they were able to fix the time of crescent moon and its first quarter. Unfortunately we are unable to submit these calculations to a practical test because we do not know to what year they refer: but we can see from the whole process, and from the results of our three tables for the years 188, 189, and 201 S.E., that they accomplished what was possible at that time.[1]

With regard to the planets we find ourselves in a somewhat difficult position. The beginning of an explanation is, however, offered by another class of tables which contain the positions of single planets in detached sections. We have before us two of these tables, the copies of which Father Strassmaier had the kindness to transmit to us. The first (now published in the *Assyriological Journal* of Dr. Bezold, vol. v. p. 341 ff., marked R^{m} 678) is from the Rassám collection in the British Museum, and contains all the planets, but each for a different year, the other was acquired last year by the American expedition of Pennsylvania University through Prof. Harper. The British table, which we have examined to some extent, contains, especially in the new copy, sufficiently clearly Jupiter (even for two years), Venus, Mercury, and Saturn—of course with few data; on the other hand, the data for Mars are for the most part damaged, but the year is visible with sufficient data to allow of its verification.

The deciphering of both tables of ephemerides first justified the wish to elucidate the matter, for the knowledge of these alone afforded a well-founded hope of revealing the partially analogous text of the others. Before attempting such a task, however, it should be established why, in the case of these last, different years for the different planets should be found together on the same tablet. This important association must have had some object beyond the scope of the tablet, because the positions of the planets are by no means in accordance. It was not far to the thought that, because the planets also have periods in their apparent paths, all data together should build up the foundation for the ephemerides of a coming year. Upon this supposition it was not difficult to determine the single years. Venus, for instance, had a period of 8 years, at the expiration of which the same apparent positions returned approximately. We will now place before the reader the years which are given for the individual planets (according to the era of the Seleucidæ), and below them the periods corresponding to those planets; which then, added to the number of the year, must in each case give the same year of that era, if the above view be correct.

Venus	228	Mercury	190	Jupiter	224	Saturn	177
Period	8	Period	46	Period	12	Period	59
	236		236		236		236

The agreement is so striking that no doubt the planetary data of these years have been used for the ephemerides of the year 236 S.E. How the transition was effected can only be recognized if for instance the ephemerides of the year 236 S.E. should be discovered.[2]

The American tablet is similarly constructed. On it the data for Saturn and Mars are completely broken off, but it contains a few more lunar dates, with the addition of the year 225 S.E., for which the combination is calculated. Jupiter is represented in this and the English one

[1] The lunar eclipse of the 2nd of August, 123 B.C. (*i.e.* −122), was 18 years before so small (magnitude 0·1 digit), that it can hardly be considered as having happened at all, the more so as the time was unfavourable for Babylon, being broad daylight.

[2] *l.c.*, p. 155.

[1] Compare J. Epping's interesting article "Die babylonische Berechnung des Neumondes" ("The Babylonian Calculation of the New Moon") in the *Stimmen aus Maria-Laach*, vol. xxxix., September 1890.

[2] In the meantime, these ephemerides of the year 236 S.E. have been found in the treasures of the British Museum, and the Rev. Jos. Epping is engaged in making the necessary calculations.

by two whole years, the one corresponding to the period 12, the other to one of 83 years, where above in the English tablet the number of the year is broken off.

A preliminary investigation makes it appear probable that we have to deal with the results of observation in both tablets. The longitudes calculated for Venus, for instance, according to the lists of dates given in the tables, differ as a rule in minutes only from the longitude of the annexed normal star, and differ always least when the latter is not far from the ecliptic, and consequently the agreement in longitude would be easiest to observe. It is further remarkable that in these cases the negative difference between ♀—✱ is the predominant one, as though the results which we receive from Le Verrier's tables for the geocentric positions of Venus were about 10′ too little. This stands out still more clearly in the case of the more scantily represented constellations of Mercury; here the negative difference rises to 1°.

The above-mentioned table of the 7th year of Cambyses (published in the *Assyriological Journal* of Dr. Bezold, vol. v. p. 281; and by Dr. Oppert, "Un Annuaire Astronomique Chaldéen, utilisé par Ptolémée," *Comptes rendus des Séances de l'Académie des Sciences*, tome cxi., séance du 17 novembre 1890; cf. Almagest, book v. ch. 14) contains no constellations at all of planets with fixed stars, but only data for the relative[1] positions of the planets, and may accordingly bring us further knowledge of their relative position at that time. This table is of greater importance for the path of the moon. The data for the time of eclipses are of less value, since their accuracy goes only to a half or a third *kas-bu* (= double-hour).

On the other hand, the data for the rising and setting of the full moon in a given case are to be estimated at a higher value. We have in this tablet clear and distinct data, for at least ten months, as to how many degrees of time before sunset the moon rose (1° = 4m.). As further subdivisions to one-sixth of a degree are given, and the observation and measurement of the slightest difference in time at the time of full moon hardly admit an error of more than 1m., the position of the moon with regard to the sun may be determined with an unusual degree of accuracy. This might raise the hope that the work of the Chaldæans might benefit even our advanced age. In the meantime it may suffice to have won again for the old astronomers the place of honour in science which was accorded to them in ancient times.

Chronological Summary.

The learned chronologist Ideler gives a convincing testimony[2] to the uncertainty which still reigned in the first half of our century with regard to the Babylonian chronology. He says, "Nowhere do we find peculiarly Chaldæan months, and in no author do we find the years reckoned according to a Chaldæan era. We shall therefore only be able to answer conjecturally the question, Of what nature was the Chaldæan chronology?"

As much may have been made clear in this domain since Ideler's time, it will be interesting to bring together the results which have been rendered certain through the interpretation of the Cuneiform Inscriptions.

First, the era of the Seleucidæ has acquired a firmness such as appertained to hardly any other before the Christian era. The data given in the tables for the years 189 and 201 S.E., indicate a unanimity of astronomical phenomena which can only belong to the years −122 and −110, and indeed with such an exclusiveness as would hardly allow of the recurrence of such a combination within a period to be measured by thousands of years. The Seleucidæan era is combined with the Arsacidæan in these tables, so that we are now able to determine both with equal certainty.

We have

−122 = 125 Arsac. E. = 189 S.E.

therefore

−246 = 1 „ = 65 „

and

−310 = 1 „

Ideler distinguished a double Seleucidæan era, a Chaldæan, and a Syro-Macedonian[1]; he made the former begin in the autumn −310, the latter in autumn −311. Dr. Eduard Mahler[2] also places the beginning of the latter in the autumn of the year −311. If we put aside Ideler's first statement, then both scholars agree with our results, but the beginning of the year is to be placed six months later in the tables in question; therefore 1 S.E. = −310. The difference in the beginning of the year may be further explained through other inscriptions. Father Strassmaier has published some Arsacidæan inscriptions in the *Assyriological Journal* (vol. iii.), and amongst these the 11th (p. 137) begins—"Sanat 170 kan Di-mit-ri-su arah Adaru," &c. Then follows "Arah Airu 14 na," without the year's number suffering any change; therefore the year 170 of Demetrius began before the month Adar, with that of Thischri—that is to say, in the autumn. The table contains a horoscope, and gives constellations for the night of the 6th Adar which suit so exclusively for the 28th February −141, that they could hardly appear again in their entirety for 200 years before or after. It follows of itself that the year of the horoscope has not been reckoned from the beginning of the reign of one of the known Demetrius. As, on the other hand, 170 S.E. is −141 (that is, 142 B.C.), it follows that the tablet is dated according to the Seleucidæan era, but with the beginning of the year in the autumn, for which reason, perhaps, Demetrius is inserted as a distinguishing point.

Perhaps the first-named view of Ideler, that a Chaldæan era existed which began exactly a year later than the Syro-Macedonian, should not be dismissed simply with a wave of the hand. Certainly, no direct evidence can be produced in support of it, but we can advocate the grounds of probability. Father Strassmaier, speaking of the fourth of the above-mentioned inscriptions,[3] remarks: "We learn with certainty from the double dates of the inscription that the year of the Arsacidæan era began with the month Thischri, while the Seleucidæan began with the month Nisan: for it is only in this way that the above figures can be understood; the month Tebeth of the year 152 is the year 216, and the month Thammuz of the year 152 is the year 217 of the Seleucidæan era." Seeing, then, that there is the same difference—64—between 152 and 216 as in the data of our first planetary table—125 equal to 189—in the case of the new year being given with Nisan at the head, 124 equal to 189 should be written. Hence it follows that the Chaldæans made the Arsacidæan era begin half a year later than the Seleucidæan. It is not impossible that the Chaldæans, in order to bring both years into harmony, put off the beginning of the year from spring to the following autumn, and this becomes probable in case of Ideler's view having positive foundation.

Two difficulties which Dr. Oppert[4] advances against the Seleucidæan and Arsacidæan eras are removed by our tables. Firstly, he agrees with Dr. Mahler, and consequently with us, that the Seleucidæan era begins with the year −311, but holds that this era can only be supposed in question when the name of Seleukos is recorded. This objection is instantly refuted by the

[1] The calculations prove that these dates are based on observations; here Mars is called Ni-bat-a-nu, and Jupiter Sag-me-ša, or Sig-me-sa.

[2] "Handbuch der mathematischen und technischen Chronologie," von Dr. Ludwig Ideler, vol. i. p. 202.

[1] *l.c.*, pp. 223 and 224.

[2] "Chronologische Vergleichungstabellen," 1 Heft, von Dr. Eduard Mahler.

[3] *Zeitschrift für Assyriologie*, vol. iii. p. 132.

[4] *Comptes rendus des séances de l'Académie*, tome cvii. pp. 467 and 468.

tables before us, and also by two others, No. 9 and No. 11, published by Father Strassmaier in the *Assyriological Journal*, for in them the era is not named after Seleukos. Besides this, there exist some unpublished tables in which the same thing occurs; and yet, as above, the years are certainly reckoned according to the Seleucidæan era. Dr. Oppert feels justified in assuming further that the Arsacidæan era begins with

1 Arsac. E. = −255 in the autumn.

He applies it in the translation of the already-mentioned Strassmaier inscription, No. 9, which contains the course of an indicated eclipse [1] of the moon. Yet if we look at the year's data in this table, we shall easily find that they agree with our own. The text runs as follows:—"Šanat 168 kan ša ši-i Šanat 232 kan Ar-ša-ka-a." It is, as we see, completely analogous to those of 189 and 201 S.E., and the difference 232 − 168 is again exactly 64. Accordingly, in this table (No. 11) apart from its contents, the eras are none other than the Seleucidæan and the Arsacidæan.

The determination of the eras in use in Babylon at the time of the Macedonian rulers, will always be fraught with some difficulties which may be more easily and confidently disposed of if astronomical data are dated according to such an era.

The years in our Seleucidæan era are so-called "bound" [2] lunar years. We know that the Babylonians had lunar months—some of 30, some of 29 days—whose number was not determined according to the mean new moon, as was the case with the Greeks, but was reckoned from the crescent moon, in close connection with the real new moon. If they wished, with regard to the number of months in the year, to remain in harmony with the solar year, they would have been obliged to fix on an average in 11 years—7 years with 12 months, and 4 with 13 months.

Like the Jews to the present day, they had intercalary months, but without intercalary days in addition. The lunar year of the Chaldæans was so vigorously defended by Fréret that even Ideler, who preferred to attribute the Egyptian year to the Babylonians, could not do otherwise than pronounce Fréret's hypothesis probable. Yet here he differed from Fréret's view in that he could not bring himself to attribute to the Chaldæans an "unbound" year—that is to say, a year of 12 lunar months. He did not dispute the *saros*, *neros*, and *sossos* [3] of the Babylonians, but he denied that these great periods were the only means through which a connection with the solar year could be restored. Ideler was, if one ascribes lunar months to the Babylonians, absolutely in favour of the "bound" lunar year. In this he has remained perfectly right. The Babylonians had real intercalary months, as we have seen, in the case of the year 189 S.E. The many inscriptions which Father Strassmaier has published testify for other years. We refer the reader to his "Nabonidus," in which the 1st, 3rd, 6th, 12th, and 15th years had a second Adar, and the 10th had further a second Elul.

The fact is therefore established, but what was the nature of the intercalation? Had the Babylonians a fixed law for it, or did they allow a choice to be made in the single years within certain periods, for instance of eleven years? The latter appears so far the most probable, for, in the event of a fixed law, two intercalary years could hardly ever follow each other, and yet we do find such cases in the communications of Father Strassmaier, although very rare and perhaps uncertain: the years 2 and 3 of Cyrus, and 11 and 12 (?) of Darius were intercalary. Dr. Oppert is also of the opinion that the intercalation has been very arbitrarily accomplished. It would seem as though the Babylonians must have found themselves in no less a dilemma from the putting back of the date some few decennaries, unless official lists of all successive months and years were strictly kept. Even if this be assumed, Ideler's objection still subsists,[1] "that they must have had a well organized chronology: otherwise how could the Greek astronomers, to whom their observations served as a foundation for a theory of the moon, have accepted their data with so much confidence?" Certainly Ideler's view, which in his time was the most general, that the Chaldæans had no era of their own, but used the Egyptian, or at best reckoned according to the moon for civil life, is, as we have seen, falling into disfavour. Our tables are of an astronomical nature, and only permit an intimation of Egyptian chronology, in the Sirius phenomena, to glance through.

Moreover, the above-mentioned opinion requires but a slight modification of form in order to appear not only acceptable, but probable. We might be led to suppose that the astronomers made use of a double chronology, one which had its foundation in the movement of the moon, another which was in accordance with the path of the sun. Otherwise how could they have determined beforehand, within a few degrees, the exact position of the planets, even of Mercury? They must have been very familiar with the length of the solar year, and probably referred their calculations first of all to a solar year of some organized form in order to transfer the results afterwards to the lunar year.

Unfortunately we possess no documents which might afford us a positive insight into the matter. With regard to the beginning of the year we have already shown that the Seleucidæan era, as it is presented in our three tables, began the year with the month Nisan, therefore in spring. It would appear that in this an old tradition was held to, for in the inscriptions published by Father Strassmaier from the reigning years of Nabonidus and Nabuchodonosor we have an accession year [2] in each case.

In the first the year extends from Sivan beyond Thischri to Adar; in the latter Thammuz [3] is evidently represented, including Thischri and Kislev, so there is full evidence that Thischri, and consequently the autumn, did not form the beginning of the year. If, then, founding the commencement of the Babylonian year [4] in the month Nisan, we postpone it to spring, we cannot well go too far.

The transference to Thischri or autumn was probably a consequence of the Macedonian rule, for the Macedonians celebrated the beginning of the year in the autumn, and, previously to the Arsacidæan era there is no inscription known which places the new year in Thischri.

If we knew the beginning of the year of all the eras in use in those times, the exact determination of date of any data might still be a matter of difficulty, because the beginning point [5] in a "bound" lunar year is always uncertain. In the first table (189 S.E.) the 1st of Nisan fell on March 25; in the other one, of 201 S.E., on April 10; and in others the variation may be much greater.

[1] A translation of this description of the lunar eclipse is to be found in the *Assyriological Journal*, vol. iv. p. 76, which still holds good against the objections of Dr. Oppert, *l.c.*, p 174.

[2] The lunar year is *bound*, when it is kept in harmony with the solar year by intercalation; *unbound*, when it contains always only 12 months, so that the beginnings of the lunar and solar year coincide only after long periods, as in the Muhammadan era.

[3] There are many different opinions about these periods: some say *saros* = 3600, *neros* = 600, and *sossos* = 60 years; others only so many days; again, some think, and perhaps with greater probability, that *saros* signifies the Chaldæan period of 18 years and 11 days, but then they are uncertain about the meaning of *neros* and *sossos*.

[1] *l.c.*, p. 202.

[2] An accession year contained the rest of the months of the current year, whenever the beginning of the reign of a new king fell in the current year.

[3] Compare the inscriptions of Nabopalassar in the *Assyriological Journal*, vol. iv. p. 121, n. 19.

[4] Dr. Oppert, in his "Chronologie Biblique," pp. 11 and 12, puts the beginning of the Assyrian year in general in Nisan, but for weighty reasons he fixes the beginning of the eponym year in Thischri or in the autumn: "les éponymies vont de Thischri à Elul, et non de Nisan à Adar."

[5] E. von Herdtl, in his "Astronomische Beiträge zur assyrischen Chronologie," p. 43, thinks that the beginning of the Assyrian year falls on the first new moon before the vernal equinox.

It is only when astronomical data are combined with Babylonian dates that we can hope to determine the corresponding Julian date.

Another similar question which chronology has to answer is, whether the change of date was reckoned according to a point of time, or according to the civil day. According to the evidence brought forward by Ideler, the ancients were convinced generally that the Babylonians reckoned the day from one sunrise till the next, and therefore made the change of date take place in the morning. Ideler finds a difficulty here, in that such a supposition would hardly be compatible with a chronology depending on the changes of the moon. We must allow that he is right, and we think we have sufficiently proved that the first day of each month coincided with the first visibility of the crescent moon. Whether the Babylonians were first prompted by the Macedonians, at the outset of the Seleucidæan era, to put off the date till evening, cannot be learnt from the documents, but it is not probable, if we disregard Pliny, Censorinus, &c., for they reckoned in lunar months earlier. If we honour these historical statements as we are bound to do, there is yet a kind of explanation to be offered.

We have seen that the Babylonians referred their calculations for the new moon to midnight, so that astronomically speaking the change of date was accomplished at this hour, so it is not impossible that they did not forestall the civil day, but let it succeed the astronomical. This is nothing but a conjecture, in order not to reject the authority of the ancients.

The last chronological element upon which we have to speak is the division of the day. It is generally accepted that the Babylonians cut up the day into twenty-four hours—twelve day and twelve night hours. There is so much evidence here that we cannot doubt the fact. Our tables show another division which was in use among astronomers. It is completely demonstrated in the calculation tables, where the whole day is split up into six divisions, and each division into sixty subdivisions, so that the whole day falls, like the circle, into 360 parts, of which one equals four of our minutes. For the sake of calculation, the subdivision is carried on to sixty, and yet another sixty. The application of this method of calculation shows itself also in the ephemerides, first of all to express the duration of visibility with regard to the moon, and also to declare the time when, according to calculation, an eclipse should happen. It is remarkable that we have here two starting-points, sunrise and sunset; while in each case it is announced how many degrees of time before or after these terms the eclipse will happen. The extreme points, therefore, for both then touched at midday or midnight.

TEMPERATURE IN THE GLACIAL EPOCH.

THE late long frost has naturally suggested the question, What permanent fall of temperature would produce a recurrence of the Glacial epoch? It is a question not easily answered, for it is like a problem complicated by too many independent variables. It is not enough for us to ascertain the actual temperature of a district in order to determine whether it will be permanently occupied by snow and ice. There are regions where the ground, a short distance below the surface, is always frozen to a depth of several yards at least; and yet glaciers do not occur, even among the hills, because the amount of precipitation is so small that the summer rapidly dissipates what the winter has collected. There are other regions partly covered by ice though their mean annual temperature is distinctly above the freezing-point; as where glaciers descend to the sea from hilly districts, of which a considerable area lies above the snow-line, and on which there is much precipitation. In the case of Great Britain, at least, a further difficulty enters into the problem—namely, that much controversy still prevails as to the interpretation of the symbols upon which our inferences in regard to the temperature of these islands during the Glacial epoch must depend. Some authorities would concede no more than that the highland districts of Scotland, Wales, and England were enveloped in snow and ice, and the glaciers, whether confluent or not, extended from their feet for a few leagues over the lowlands—say, to some part of the coast of Lancashire and of Northumberland; while others desire to envelop a large part of the British Isles in one vast winding-sheet of ice, a corner of which even rested on the brow of Muswell Hill, above the valley of the Thames. The one school regards the Boulder Clay of England as a deposit mainly submarine, the product of coast-ice and floating ice in various forms; the other attributes it exclusively or almost exclusively to the action of land-ice. Into this thorny question we do not propose to enter. The approximation which we shall attempt—and it can only be a rough one—can be easily modified to suit the requirements of either party.

We will assume throughout that the annual isothermal of 32° coincides with the line of permanent snow. This, obviously, is an assumption; often, owing to small precipitation, it will be found to be erroneous, but we take it as the only simple approximation, for, under favourable circumstances, masses of ice may protrude beyond it.

The question, then, may be put in this form. Assuming a sufficient amount of precipitation, what changes of temperature are required in order to bring within the isothermal of 32° regions which are generally admitted to have been occupied by land-ice during some part of the Glacial epoch?

First, in regard to the British Isles. All will admit that in many places the Cumbrian and Cambrian glaciers descended to the present sea-level. The mean temperature of the Thames Valley near London is 50° F. This isotherm cuts the Welsh coast a little east of Bangor. Obviously, the whole region north of this line has a lower mean temperature, no part of the British Isles, however, being below 45°. Hence a general fall of 18° would give a temperature of 32° at most in the Thames Valley and on the shores of North Wales (except on the extreme west), while on the coasts further north the temperatures would range down to 27°. What would be the effect of this? Switzerland may enable us to return an answer. The snow-line in the Bernese Oberland may be placed roughly at 8000 feet above the sea, but it is obvious that the chief feeding-ground of the Alpine glaciers lies rather higher up in the mountains. In the case of such glaciers as the Great Aletsch, or the Aar, the lowest gaps in their upper basins are rather above 10,000 feet, while the surrounding peaks range, roughly, from 12,000 to 14,000 feet, though but few exceed 13,000 feet. Thus the feeding-ground of the Oberland glaciers may be regarded as equivalent to a mountain district the sky-line of which ranges from rather above 2000 to 5000 feet. In reality, however, not very much of it exceeds 4000 feet above the snow-line. This, indeed, rather overstates the case. We find practically that the effective feeding-ground, that which gives birth to glaciers, which protrude for some distance below their supply basins, may be placed about 1000 feet above the ordinary snow-line; so that the glacier-generating region of Switzerland may be regarded as equivalent to a mountain district with passes about 1500 feet, and peaks not often exceeding 3000 feet. It follows, then, that if the temperature at the sea-coast in North Wales were 32°, the whole of the Scotch Highlands, and a large part of the Cumbrian and Cambrian Hills would become effective feeding-grounds, and the glaciers would be able to descend into the plains. In the Alps, the larger glaciers terminate at present at altitudes of from 4000 to 5500 feet (approximately); that is, they descend on

an average about 4000 feet below the effective feeding-ground, or 3000 feet below the snow-line. If the temperature of Bangor were not higher than 32°, then the Snowdonian district would be comparable with one of the Alpine regions where the mountains rise generally from about 1000 to 3000 feet above the snow-line; that is, with such a one as the head of the Maderanerthal, where none of the peaks reach 12,000 feet above the sea. Here the Hüfi Glacier leads to passes rather below 10,000, among peaks of about 11,000 feet in altitude, and it terminates a little above 5000 feet. That is to say, a region, rising roughly from 2000 to 3000 feet above the snow-line, generates a glacier which descends more than 2000 feet below it.

But what change is required to give a Glacial epoch to Switzerland? It is generally agreed that an ice-sheet has enveloped the whole of the lowland region between the Alps and the Jura. Let us assume that, other conditions remaining the same, this could occur if the mean annual temperature of this lowland were reduced to 32°. Its present mean temperature varies somewhat; for instance, it is 45°·86 at St. Gall, 49°·64 at Lausanne. Let us take 47°·5 as an average, which is very nearly the mean temperature of Lucerne.[1] So this lowland requires a fall of 15°·5. We may take the average height of the region as 1500 feet above the sea. If, then, we begin the effective gathering ground at 1000 feet higher, the valley of the Reuss from well below Wasen, and the valley of the Rhone from a little above Brieg, would be buried beneath *névé*. So that probably a fall of 16° would suffice to cover the lowland with an ice-sheet, and possibly bring its margin once more up to the Pierre-à-bot above Neuchâtel; at any rate, a fall of 18° would fully suffice, for then the mean temperature of Geneva would be slightly below 32°.

The line of 41° passes through Scandinavia a little north of Bergen; if, then, the climate of Norway were lowered by the same amount, which also is that suggested for Britain, the temperature at this part of the coast would be 23°, corresponding with the present temperature of Greenland rather south of Godhavn; and probably no part of Norway would then have a higher mean temperature than 26°.

The wants of North America are less rather than greater; though, as geologists affirm, an ice-sheet formerly buried all the region of the Great Lakes and descended at one place some fifty leagues south of the fortieth parallel of latitude. Its boundary was irregular; but if we strike a rough average, it may be taken as approximately corresponding with the present isotherm of 50°. The temperatures, however, in North America fall rather rapidly as we proceed northwards. Montreal is very nearly on the isotherm of 45°, and this passes through the upper part of Lakes Huron and Michigan; that of 39° runs nearly through Quebec and across the middle of Superior, while at Port Arthur, on the same lake, the temperature is only 36°·2. If, then, we assume sufficient precipitation, the maximum fall of temperature required for this North American ice-sheet will be 18°; but less would probably suffice, for the district north of the St. Lawrence would be a favourable gathering ground. This would be brought within the isotherm of 32° by a fall of 12° or at most of 13°.

It seems, then, that if we assume the distribution of temperature in the northern hemisphere to have been nearly the same as at present, we require it to have been lowered, at any rate in the regions named, by about 18° in order to bring back a Glacial epoch. For North Wales a reduction of about 20° might be needed, but if the isotherms ran more nearly east and west, 18° for the Thames Valley might suffice. If we assume the great extension of glaciers in Central and North-Western Europe to be contemporaneous with that in America, we must suppose that these parts of the northern hemisphere had a climate more nearly resembling, but even colder than, that which now prevails in the southern hemisphere. The isotherm of 40° runs a little to the south of Cape Horn; that of 45° passes north of the Straits of Magellan. The latter lie on parallels of latitude corresponding with those of North Wales, but their mean temperature is about 8° lower. If we could restrict ourselves to the British Isles, it would be enough to assume a different distribution of temperature from that which now prevails on the globe, for at the present time, and in the northern hemisphere, the isotherm of 32° twice comes down very nearly to the latitude of London; but it may be doubted whether this alone would account for the great extension of the Alpine glaciers, and the difficulties seem yet greater in the case of North America. Here, where even at present the temperature is rather abnormally low, we have to make a very considerable reduction. But this is too wide a question to discuss at the end of an article in these pages. We seem, however, fairly warranted in concluding that, whatever may have been the cause, a lowering of temperature amounting to 18°, if only the other conditions either remained constant or became more favourable to the accumulation of snow and ice, would suffice to give us back the Glacial epoch.

T. G. BONNEY.

[1] St. Gall, 45°·86 F.; Berne, 46°·58; Lucerne, 47°·48; Zurich, 48°·20; Neuchâtel, 48°·74; Geneva, 49°·46; Lausanne, 49°·64. St. Gall and Berne are rather high stations, the one being 2165 feet, the other 1760 feet. The lake of Lucerne is 1437 feet above the sea.

SURVEYING AND LEVELLING INSTRUMENTS.[1]

THIS volume fills a gap that has been long felt in consequence of the great dearth of good books treating of instruments used for surveying and levelling. Various books and pamphlets contain descriptions and methods of using instruments of this class, but there is no work in which each instrument is so completely treated as in the present volume.

The author's former work, which has been found to be a most useful help and guide, and is now in its sixth edition, was limited to drawing instruments, among which were those for plan drawing and calculation of areas. The present work is intended to complete the subject by describing theoretically and practically the different instruments that are required and used at the present day. Not only does the author give an excellent and complete description of each typical instrument, but in many cases he shows the methods of use adopted in the field; thus placing before us a good and trustworthy text-book.

Of the instruments treated therein, one is surprised at the many and various kinds that are in use. Among some of the less common instruments we may mention a tacheometer, our illustration (Fig. 1) showing the author's latest pattern of this instrument. As regards its general appearance, it differs very slightly from a theodolite, but, when closely examined, it will be found that the graduation of the arcs and circles is made upon the centesimal system, the circle reading 400 grades, and reading to 0·01 grade by a micrometer or vernier. The compass is of the cylindrical form, and is inside the small telescope placed below the horizontal circle, and is read by a very ingenious method. The telescope is made of a much larger size and of higher power than those generally employed in theodolites. To facilitate calculation, a logarithmic slide-rule forms part of the equipment of this instrument. A very neat and ingenious mining survey transit, the result of various improvements suggested by the author, is illustrated in Fig. 2. It should be found of

[1] "Surveying and Levelling Instruments." By William Ford Stanley. (London: E. and F. N. Spon, 1890.)

the utmost value when used in close working, for the circles are so arranged that they can be very easily read, the horizontal circle being so adjusted that the reading can be taken when the instrument is near the roof of a mine. The telescope has a wide field of view, and on it are

FIG. 1.

placed two pairs of sights made on a new principle for roughly sighting an object or station, or for use in difficult positions.

Another very compact little instrument which has been improved by the author is the box sextant with a continuous arc of 240°.

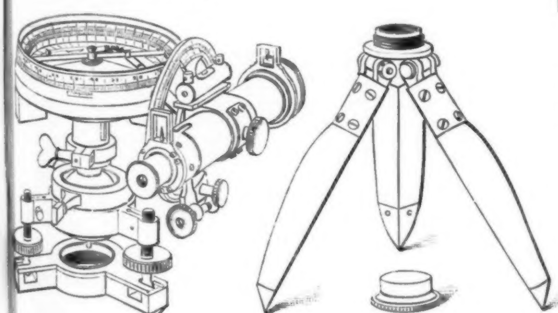


FIG. 2.

Among the miscellaneous instruments described at the end is mentioned a portable saw made of hardened steel plates riveted together in double series, and slack enough to allow the rivets to form joints. This saw "is equal to a 6-foot cross-cut saw, weight complete $2\frac{1}{4}$ pounds, including case, which measures over all $1\frac{3}{4}$ by 4 by 8 inches. Two men with this saw may cut a tree down, 12 inches in diameter, in about 10 minutes."

We need only say in conclusion that the work is deserving of the highest praise, and will be found invaluable to surveyors and others whose work makes it necessary for them to use or study instruments of this kind. For besides laying before the students of surveying or mining the principles and methods of use of each instrument of its class, and also the best tests for assuring the qualities of each, it provides information which will be of much service to skilful instrument makers. W.

PROFESSOR SOPHIE KOVALEVSKY.

THE Swedish papers bring us the sad news of the death of the lady-Professor of Mathematics at the Stockholm University, Mme. Sophie Kovalevsky. She spent her Christmas holidays in the south of France, returned to Stockholm on February 4, and began her course of lectures on the 6th. On the evening of that day she felt ill, and on the 10th she died of an attack of pleurisy. She was born in 1853 at Moscow, and spent her early childhood in a small town of West Russia, where her father, the general of artillery Corvin-Krukowski, was staying at that time; and afterwards on her father's estate in the same part of Russia. She received her first instruction from her father, but it seems that it was her maternal uncle, an engineer of some renown, Schubert, who awakened in her an interest in natural science. She early lost both her mother and her father, and, having ardent sympathy with the movement which was spreading among Russian youth, she applied for, and at last obtained, permission to study at St. Petersburg. The next year—that is, in 1869, when she was but sixteen years old—she was received as a student at the Heidelberg University, and began the study of higher mathematics. About this time, when extremely young, she married Kovalevsky, the well-known Moscow Professor of Palæontology. From 1871 to 1874, she was again in Germany, this time at Berlin, studying mathematics under Weierstrass; and at the age of twenty-one, she received the degree of Doctor of Philosophy at Göttingen. Her husband died in 1883, and the next year, in June, she was offered the chair of higher mathematical analysis at the Stockholm Högskola, on condition that she should lecture during the first year in German, and afterwards in Swedish. This she did, and most successfully too—some of her Swedish pupils already being professors themselves. Her chief mathematical papers were: "On the Theory of Partial Differential Equations" (in *Journal für Mathematik*, 1874, vol. lxxx.): "On the Reduction of a class of Abel's Integrals of the Third Degree into Elliptical Integrals" (in *Acta Mathematica*, 1884, vol. iv.)—both being connected with the researches of Weierstrass; "On the Transmission of Light in a Crystalline Medium" (first in the Swedish *Förhandlingar*, and next in the *Comptes rendus*, 1884, vol. xcviii.), being part of a larger work in which Mme. Kovalevsky shows the means of integrating some partial differential equations which play an important part in optics; and "On a Particular Case of the Problem of Rotation of a Heavy Body around a Fixed Point" (in the *Mémoires* of the Paris Academy: *Savants étrangers*, vol. xxxi., 1888). The third of these works received from the French Academy the Prix Baudin, which was doubled on account of the "quite extraordinary service" rendered to mathematical physics by this work of Sophie Kovalevsky. She was also elected a Corresponding Member of the St. Petersburg Academy of Sciences.

Besides her mathematical work, Sophie Kovalevsky had lately begun to give literary expression to her ideas

The autobiography of her early childhood ("Reminiscences of Childhood"), published last year in a Russian review, is one of the finest productions of modern Russian literature. In 1887 she published in the Swedish review *Norna* the introduction to her novel, "Væ Victis!" And in the last issue of the *Nordisk Tidskrift* she brought out, under the pseudonym of Tanya Rerevski, a fragment of a longer novel, "The Family of Vorontsoffs," which she left in manuscript entirely ready for the printer. In her last letter to the writer of these lines in December last, she spoke of bringing out an English version of this novel, which, though written in Russian, could not be published in her mother country.

It need not be said that so highly gifted a woman as Sophie Kovalevsky was modesty itself. She took the liveliest interest in Swedish intellectual life, and had many friends both in Stockholm and in this country, which she visited last year. She leaves a daughter eleven years old. The Swedish papers speak with the greatest sympathy and regret of *their* professor "Sonya" (the little Sophie) Kovalevsky.

In Mme. Kovalevsky's "Reminiscences of Childhood," she records a fact well worthy of note. She was then about ten years old, staying in her father's house in the country. The house was being repaired, and wall-papers were brought from St. Petersburg; but it so happened that there was no wall-paper for the nursery. So it was papered with the great Ostrogradski's lithographed course upon higher mathematical analysis—a survival of her father's student years; and the little Sophie, who devoured everything printed within her reach, to the despair of her English governess, was continually reading these mathematical dissertations covered with incomprehensible hieroglyphs. "Strangely enough," she says in her memoirs, "when, at the age of sixteen, I began studying the differential calculus, my teacher was astonished at the rapidity with which I understood him—'just as if it was a reminiscence of something that you knew before,' he said. The continual reading of the wall-papers certainly left some unconscious traces in my childish mind."

P. K.

NOTES.

THE Bureau of the International Congress of Geologists has decided that its fifth session shall be held at Washington, and the date of the session has been fixed for the last Wednesday (26th) of August 1891. The annual meeting of the American Association for the Advancement of Science and the summer meeting of the Geological Society of America will be held in the same city during the preceding week. A circular, signed by J. S. Newberry, chairman, and H. S. Williams and S. F. Emmons, secretaries, has been issued, cordially inviting geologists to take part in the labours of the Congress, and, if they desire to do so, to address their request for inscription as members of the Congress to the Secretary's office (1330 F Street, Washington, D.C.). The Committee of Organization will try to obtain from the ocean steamship lines the most favourable terms for the transportation of foreign members to and from the United States, and to arrange with the respective railroad companies for reduced rates for the geological excursions. They point out that, to accomplish this satisfactorily, it is important they should know beforehand the approximate number of members who propose to attend the meeting. They desire also to have an expression of opinion from these members in order to arrange in advance a series of excursions to places that will be of interest to the greatest number. Owing to the large number of points of geological interest, and to the great distances to be traversed, it would be impossible for the Committee to arrange these excursions, so that their expense should fall within reasonable limits, without some such previous information.

IT has been arranged that the afternoon meeting to celebrate the Chemical Society's jubilee, on February 24, at 3 p.m., shall be held in the theatre of the London University, Burlington Gardens, instead of at the Society of Arts, as the number of Fellows who have notified their intention of attending the celebration is larger than can be accommodated in the meeting-room of the Society of Arts. A number of distinguished foreigners are expected to be present—M. Gautier, President; M. Combes, Vice-President; and M. Haller, member of Council of the Société Chimique de Paris; Drs. Wichelhaus and Will, of Berlin, representing the Deutsche Chemische Gesellschaft; and Prof. Victor Meyer, of Heidelberg.

LORD LILFORD AND MR. WILSON NOBLE deserve the thanks of all genuine lovers of nature for calling attention to the scheme whereby an enterprising Birmingham Company proposed to take from the Shetland Islands, during the approaching spring, no fewer than 20,000 eggs, including "many beautiful and rare varieties." A question on the subject was asked in the House of Commons on Tuesday by Mr. W. James, in reply to whom the Lord Advocate suggested that Mr. A. Pease's Wild Birds' Protection Bill, which had been read a first time, might afford an opportunity for extending to the eggs of wild birds the protection at present given to wild birds themselves. In accordance with this suggestion, Mr. W. Noble proposes to move an instruction to the Committee on Mr. Pease's Bill extending the operation of the measure to birds' eggs. Meanwhile, the Birmingham Company has announced that the proposed "oological expedition" has been abandoned.

THE Cambridge Medical Graduates' Club are to give a dinner to Sir G. M. Humphry, F.R.S., at the Marlborough Rooms, Regent Street, next Tuesday.

ON Sunday, February 8, a *fête* was held at Naples in honour of the fiftieth anniversary of Prof. Arcangelo Scacchi's Professorship of Mineralogy in the University of that city. The large hall of the apartments of the Royal Academy was crowded by delegates from all the Universities of Italy, as well as some foreign ones. Nearly every scientific institution of Italy, and not a few institutions of other nations, were represented. The Geological Society of London and the Mineralogical Society of Great Britain had deputed Dr. Johnston-Lavis to convey their congratulations to the eminent mineralogist, who on that day attained the age of eighty-one years. Prof. A. Scacchi was deeply touched by the numerous speeches, and especially by that of the Mayor of Gravina di Puglia, where the Professor was born, and where a true hero worship has sprung up around his name. A large gold medal, bearing on one side the head of the veteran man of science, and on the other a suitable inscription, was presented to him, together with a beautiful illuminated parchment executed by Mr. L. Sambon. Much credit is due to the committee, and especially to Profs. Bassani and Oglialoro, the Secretary and Treasurer, for the succcess of the celebration. A pamphlet will be printed containing a biography of Prof. A. Scacchi, a list of his works, an account of the celebration, and the different congratulatory letters, telegrams, and speeches on the occasion; and a copy will be sent to each subscriber. Prof. A. Scacchi has resigned the Chair of Mineralogy, and his son, a promising young investigator, Prof. Eugenio Scacchi, takes his place in the University of Naples.

THE French scientific journals record the death of M. Jacques Armengaud, well known as an engineer, and formerly a professor at the Conservatoire des Arts et Métiers. He was the author of some important technological works.

THE interesting ethnographical collections brought by M. Charles Rabot from Siberia are now being exhibited in Paris.

THE veteran botanical explorer, Mr. C. G. Pringle, has brought back from Mexico a collection of about 20,000 specimens of plants, among which he believes there are a large number of new and rare species.

A SOCIETY of the Natural Sciences for the West of France is being founded at Nantes, under the auspices of the Director of the Museum of Natural History in that town. Its objects embrace the encouragement of the study of zoology, botany, geology, and mineralogy in the west of France, in connection with the Museum of Natural History at Nantes. It is intended to hold a meeting of the Society every month, and to publish a *Bulletin*, the first number of which is to appear in July.

ON Tuesday evening Lord E. Hamilton asked the First Lord of the Treasury whether his attention had been drawn to Mr. Elliott's invention for the annihilation of smoke, now on view on the Thames Embankment; and whether it was the intention of the Government to give the invention a trial, with a view to the possibility of taking some steps to abate the smoke nuisance in the metropolis. Mr. W. H. Smith, in reply, said he was not personally acquainted with the apparatus in question, but he was informed by the Metropolitan Police, whose duty it was to enforce the Acts relating to the smoke nuisance in the metropolis, that smoke had been observed to issue from the chimney on the Thames Embankment, from which it might be inferred that the apparatus was not at all times successful.

THE February number of the *Kew Bulletin* opens with an interesting paper on Ipoh poison of the Malay peninsula. In Java the Upas tree furnishes a very effective arrow poison; and, finding the same tree on the mainland, the Malays used its juice. Here, however, the juice is innocuous; and, according to Griffith, the defect is remedied with arsenic. The writer in the *Bulletin* says that "if this is really done it must be when the arrows are prepared, for two authentic specimens of Ipoh poison from the Malay peninsula were absolutely inert, and contained none of the poisonous principle antiarin." This article is followed by instructive papers on Kath or Pale Cutch, the production of cane-sugar in the sugar-cane, timber of Yoruba-land, phylloxera, the botanical station at Lagos, and the mealy bug at Alexandria. Along with the February number, Appendix I. for 1891 is issued. It consists of a list of such hardy herbaceous annual and perennial plants as well as of such trees and shrubs as matured seeds under cultivation in the Royal Gardens, Kew, 1889. These seeds are available for exchange with colonial, Indian, and foreign Botanic Gardens, and with regular correspondents of Kew. The seeds are for the most part available only in moderate quantity, and are not sold to the general public.

AT the last meeting of the scientific committee of the Royal Horticultural Society, the Rev. W. Wilks showed specimens of the injuries observed on shoots of peach-trees which were in contact with galvanized wire during the recent severe frost. The shoots at the point of contact with the wire were apparently blackened and frozen through, so that the distal part of a shoot, although for a short time it retains its healthy appearance, shortly dies of starvation. Similar illustrations have been before the committee on other occasions. At the same meeting Prof. F. Oliver displayed a number of water-colour drawings showing the effect of fog on the leaves and flowers of various plants; but he reserved a full statement of his observations till a future time.

MR. T. S. BRANDEGEE will publish, in the Proceedings of the Californian Academy of Science, the results of his recent botanical explorations in California.

MM. PORTA AND RIGO have returned from their botanical expedition to Spain, in which they were greatly hindered by the extraordinarily wet weather in the Peninsula last summer. Their chief explorations were in Murcia, and in the neighbourhood of Carthagena and Alicante; they have discovered some new species, and others previously unknown in Europe.

A BIOLOGICAL station will be opened in summer at the Plöner See, in East Holstein; and in view of the importance, scientific and practical, of the investigations which are to be carried on in connection with it, the Prussian Government has consented to set apart for it an annual grant during the next five years. Many private subscriptions have also been promised.

AN interesting case of the evidence of the northern and eastern extension of the Gulf Stream in Arctic regions is quoted in the *Times* of the 12th inst. A message inclosed in a bottle which was thrown, on July 3, 1890, from the s.s. *Magnetic* off the Westmanna Islands, lying to the south of Iceland, has just been returned to the writer in Liverpool, the bottle having been picked up in the Nufsfjord, Lofoden Islands, by the s.s. *President Christie*, on January 15. The bottle drifted 890 nautical miles in six months and a half.

MR. H. C. RUSSELL has published the results of meteorological observations made in New South Wales during 1888. There is a considerable reduction in the bulk of the volume for this year, as the details referring to rainfall are published in a separate work. The mean temperature of the whole colony for the past eighteen years is 61°·2, and the mean for the past year is 62°·3, or 1°·1 in excess of the mean. Anemometers are now erected at six stations, and show that at the inland stations the amount of wind recorded is little more than one-third of the amount shown by the Sydney record. The results of rain and river observations for 1889 show that the year was a very favourable one: the average rainfall for the whole colony for 1889 was 29·25 inches, being 21·7 per cent. above the average, obtained from the mean of all the complete records for the year. The number of volunteer observers is now 960, and Mr. Russell states that the interest in rainfall records is rapidly increasing. In addition to the meteorological observations published in these volumes, a complete system of weather telegraphy is maintained; two weather maps are issued daily, containing observations from eighty stations.

THE Hunterian Oration was delivered by Mr. Jonathan Hutchinson, F.R.S., last Saturday, in the theatre of the Royal College of Surgeons. Mr. Hutchinson drew a very interesting parallel between Aristotle and Hunter. That they exhibited great differences he admitted; and some of these he pointed out. He contended, however, that where the two men met on common ground they showed similar habits of thought, and intellectual powers not very unequal. Both were systematic and enthusiastic zoologists, in times when the study of zoology was the pursuit of very few. Both saw clearly that advance in natural history knowledge could be made only by the collection of facts, and, realizing that such advance was well worth the effort, both set themselves zealously to work. "It is probably not possible," said Mr. Hutchinson, "to mention a third name which can be placed in any sort of competition with either in respect to originality of effort in this direction. It has been asserted, by one well able to form an opinion in this matter, that between Aristotle and the German Kant no metaphysician of original power appeared. In like manner we might say, in reference to scientific zoology, that there was no one between Aristotle and John Hunter. There were, of course, many who made meritorious efforts with more or less success, but none whose achievements can in the least compare with Aristotle's account of the parts of animals or with John Hunter's museum. During the long twenty centuries that were passed

through between these two men, there did not appear anyone so capable of applauding Aristotle's work as Hunter—not one who would have contemplated Hunter's preparations with more true interest than Aristotle. Nor must we, in admitting Hunter's inferiority in scope of attainment, forget the great difference in their occupations. Aristotle, although the son of a doctor, did not practice physic himself, and he was throughout liberally provided with funds. During the most prosperous part of his career, his pupil, Alexander the Great, not only supplied him with money, but collected specimens for him in distant lands—a zealous collector of specimens, as has been remarked by Sir Alexander Grant. Never before or since was the endowment of research on so liberal a scale. It is only justice to our own countryman to remember that no such fortune had fallen to his lot. He had to earn every pound that he expended in zoological science in the practice of a toilsome profession, to which also he was compelled to devote the better half of his thoughts. He, like many other devotees of science, was under the compulsion to earn a livelihood in other pursuits—a position not wholly unlike that of the Jews of old, who rebuilt the walls of Jerusalem with a trowel in one hand and a sword in the other."

At the Royal Academy of Lyncei on December 18, Signors Sella and Oddone gave an account of some researches on the distribution of magnetism in certain regions on the Alps. They have found a number of magnetic foci, and record that the rocks which present distinct magnetic properties are magnetite, serpentine, diorite, melaphyre, and syenite. A magnetic rock was observed by Signor Sella on Punta Giufetti, in the Monte Rosa group, and, as it presented traces of fusion on its surface, as if it had been struck by lightning, it is suggested that this circumstance has endowed the rock with its magnetic properties.

We are glad to see that the Natural History Museum at South Kensington has recently received some valuable additions. The skeleton of a whale, never before seen in this country, has been brought from the Behring Sea. The only places where this whale (*Rhachianectes glaucus*) is now found are in the northern parts of the Pacific and in the Sea of Kamtschatka; but the animal is supposed to have had a far wider range than this in consequence of the fossil remains of this species (or a nearly identical one) having been discovered in Norway and Sweden. Among other additions are pieces of amber, 600 in number, inclosing beetles, insects, and even some small lizards.

From the official report of the Japanese census, taken on December 1, 1889, it appears that the number of houses in the whole of Japan is 7,840,872, and the total population 40,702,020. The above population divided according to classes gives the following results: nobles and their families, 3,825; old military class, 1,993,637; common people, 38,074,558. These figures, compared with the census taken in 1888, show an increase of 38,046 houses, and of 464,786 persons. Statistics of ages are also given, and from them it appears that at the close of 1889 there were 65 persons who had attained their hundredth year in Japan; 45 their hundred and first year; 13 their hundred and second year; 11 their hundred and third year; 1 his hundred and fourth year; 9 their hundred and fifth year; 3 their hundred and sixth year; 1 his hundred and seventh year; and 1 his hundred and ninth year. The cities and prefectures having populations of over a million numbered 15, that of Tokio being given at 1,138,546, but this includes not only the city but also a considerable administrative area around.

During the present season an attempt is to be made to extend our knowledge of the wild tribes inhabiting the borderland of Burmah, between Bhamo and the Chinese frontier on the one hand, and between the Northern Shan States and the Chinese frontier on the other. Lieutenant Daly, Superintendent of the Northern Shan States, and Lieutenant Eliott, Assistant Commissioner, will spend the greater part of the next six months exploring these regions. The former will have with him an escort of fifty men of the military police, and will be accompanied by Mr. Warry, of the Chinese Consular Service, and Lieutenant Renny Tailyour, of the Survey Department. He starts from Lashio, and will visit the States on the Salween, including the important State of Kyaingyanyi, and will then return along the supposed Chinese border, ascertaining its situation as accepted on the spot, and the nature of the country and the tribes inhabiting it. Mr. Eliott will start from Bhamo, and will be accompanied by Major Hobday, of the Survey Department. These officers also will be supplied with an escort of military police. They will probably proceed up the right bank of the Irrawaddy to the bifurcation of the river, and then will cross and examine the country on the Chinese border on the left bank. The country is practically unknown at present, and it is expected that much information of an interesting nature will be collected by the exploring parties. The explorers will, of course, confine their attention to the British side of the border, and when the time comes for the formal demarcation of the frontier by a joint Commission of Chinese and British officials, the information now to be collected will, no doubt, prove useful.

A further paper upon azoimide or hydrazoic acid, N_3H, is published by Prof. Curtius, of Kiel, in conjunction with Herr Radenhausen, in the new number of the *Journal für praktische Chemie*. It will be remembered that in the earlier work upon this remarkable substance, a full account of which will be found in Nature, vol. xlii. p. 615, the free azoimide was obtained as a gas by the action of sulphuric acid upon the sodium salt N_3Na. It was not found possible to collect the gas in the anhydrous state, owing to its great affinity for water. Since the publication of the first communication, however, an improved method of preparing the solution of the acid in water by distilling a soda solution of the hippuryl compound with dilute sulphuric acid has been discovered, and the details of this process were described in Nature, vol. xliii. p. 21. In the present communication to the *Journal für praktische Chemie*, Prof. Curtius and Herr Radenhausen make the important announcement that they have at length succeeded in isolating pure anhydrous azoimide itself. They find that it is only a gas at temperatures above 37°C., at which temperature, under ordinary atmospheric pressure, it condenses to a clear, colourless, and very mobile liquid of phenomenally explosive nature. The liquid possesses the intolerable odour of the gas and the aqueous solution. It is readily miscible with either water or alcohol. It was obtained by the successive fractionation of the concentrated aqueous solution, the first fraction being condensed separately and refractioned. On repeating this process four times, an acid containing over 90 per cent. of N_3H was obtained. The last traces of water were finally completely removed by means of fused calcium chloride. The anhydrous liquid, when one is fortunate in carrying out a distillation in safety, is found to boil constantly without decomposition at + 37° C. But it explodes with extraordinary violence when suddenly heated, or when touched with a hot body, and also most erratically sometimes without apparent provocation at the ordinary temperature, with production of a vivid blue flame. It unfortunately explodes in the Torricellian vacuum at the ordinary temperature, thus preventing the determination of its density by Hofmann's method. The explosion of a quantity weighing only 0·05 gram was sufficient to completely pulverize the apparatus, the mercury being driven in fine particles into every corner of a large laboratory. Upon a subsequent occasion a quantity of the liquid amounting to no more than 0·7 gram suddenly exploded upon merely removing the tube con-

taining it from the freezing mixture in which it had been immersed. Such was the force of this explosion that every glass vessel in the vicinity was completely shattered by the concussion, and it is a matter of great regret that Herr Radenhausen was seriously injured by it. As regards the relative strength of the acid, Prof. Ostwald, who has made determinations of its conductivity, finds that it is a little stronger than acetic acid. In reply to the recent suggestion of Prof. Mendeleeff that the ammonium salt of azoimide, N_3NH_4, might possibly undergo an isomeric change analogous to the conversion of ammonium isocyanate into urea, it is shown that this is not the case. The ammonium salt is a substance crystallizing in beautiful large prisms which possess the property of continually diminishing in size and eventually of entirely disappearing, owing to spontaneous sublimation. Neither sublimation nor boiling with water effect any change of constitution whatever.

THE additions to the Zoological Society's Gardens during the past week include a Red Deer (*Cervus elaphus* ♀), British, presented by Mr. C. J. H. Tower, F.Z.S.; six Night Herons (*Nycticorax griseus*), European, presented by Mr. A. A. van Bemmelen; a Spotted Eagle Owl (*Bubo maculosus*) from South Africa, presented by Mr. Julius Wilson; a Redwing (*Turdus iliacus*), British, presented by Mrs. J. B. Capper; two Yellow-throated Rock Sparrows (*Petronia petronella*) from Africa, deposited; seven Knots (*Tringa canutus*), two Bar-tailed Godwits (*Limosa lapponica*), European, purchased.

OUR ASTRONOMICAL COLUMN.

VARIABILITY OF THE ANDROMEDA NEBULA.—The January number of the *Monthly Notices of the Royal Astronomical Society* contains a note by Mr. Isaac Roberts, entitled "Photographic Evidence of Variability in the Nucleus of the Great Nebula in Andromeda." Between 1885 and 1890 a dozen photographs of this object were taken on several plates; and especially on three negatives taken with exposures of 5, 15, and 60 minutes in December 1890, the nucleus of the nebula has a decidedly stellar appearance. Other plates, exposed for both short and long intervals of time, show no trace of a stellar nucleus. It may therefore reasonably be inferred that the nucleus of the nebula is variable.

ECCENTRICITIES OF STELLAR ORBITS.—In the current number of *The Observatory* Dr. T. J. J. See points out that the arithmetical mean eccentricity of 50 of the best stellar orbits hitherto computed is 0·5, while the mean eccentricity for the orbits of the planets of our system is less than one-tenth of this fraction. A discussion of binary systems has led the author to the conclusion that the great eccentricities observed have been developed by the continual action of tidal friction. The elongated forms of most stellar orbits, and the relatively large mass-ratio of the components of a system, are so different from the orbits and relative masses in the solar system that "the development of the solar system seems to have been an exception and not the rule. From these considerations the writer would venture the opinion that investigators of cosmogony who have looked upon the solar system as typical of the general process of cosmic development, and proceeded therefrom to investigate stellar evolution in general, have pursued an erroneous path."

A NEW NEBULA NEAR MEROPE.—Mr. E. E. Barnard, of Lick Observatory, contributes a note "On the Nebulosities of the Pleiades, and on a New Merope Nebula," to *Astronomische Nachrichten*, No. 3018. Whilst examining the Pleiades on November 14, 1890, Mr. Barnard discovered a new and comparatively bright round cometary nebula close south and following Merope. Since this date the nebula has been observed several times and its position determined. The reason why such a comparatively bright object has never been photographed is that the exposure which it would require to impress itself upon the photographic plate would over-expose Merope so much that the light of the two would coalesce.

NAMES OF ASTEROIDS.—Dr. Palisa has given the following names to asteroids discovered by him last year:—

(290) Bruna, discovered March 20, 1890.
(291) Alice, „ April 25, „
(292) Ludovica, „ „ „ „
(295) Theresia, „ August 17, „

THE BRITISH MOSSES.[1]

I.

I CANNOT lay the following paper before the readers of NATURE without repeating an apology which I addressed to my audience at the Royal Institution on this subject. I can make no pretence to speak with authority; I speak only as a learner who has devoted to the subject some leisure from amidst avocations of a very different kind. But the pleasure I have derived from the study, the sense, whenever I am in the country, that I am surrounded with a world of variety and beauty of which I was formerly only dimly conscious, and the hope of communicating some of this pleasure to others may, I hope, furnish some apology for my venturing to speak on the subject.

Classification.—Without entering into any question as to the best classification of the mosses, or the relative systematic value of the different groups, the following table, which is arranged in an ascending rank, will be sufficient to show the position of the mosses in the vegetable kingdom, and the principal groups into which they may be divided:—

TABLE A.

		Series.	Orders.	Examples.
Vascular Cryptogams				
Muscineæ	i. Musci	Pleurocarpæ		Hypnum
		Acrocarpæ	Stegocarpæ	Polytrichum
			Cleistocarpæ	Phascum
		Anomaleæ	Schizocarpæ	Andræa
			Holocarpæ	Archidium
	ii. Sphagnaceæ			
	iii. Hepaticeæ	Jungermanniaceæ		
		Marchantiaceæ		
Algæ, &c.				

From this table it will be gathered that the mosses, using that word in its wide signification, stand at the head of the cellular cryptogams, and that above them are the vascular cryptogams, of which the ferns are one of the best-known groups. From these vascular cryptogams the mosses are, however, separated by a distance which Goebel has described as a chasm "the widest with which we are acquainted in the whole vegetable kingdom."

From the table it will be further seen that the larger group of the Muscineæ divides itself into three principal smaller groups: the Hepaticæ or liverworts, the Sphagnaceæ or turf mosses, and the Musci or true mosses—urn-mosses, as they have been called, from the form of their capsule. Passing over the other subdivisions, it may be observed that the Acrocarpous mosses are those which carry their capsules at the end of the axis of growth, whilst the Pleurocarpous mosses bear their fructification on stalks, more or less long, proceeding from the sides of the axis. Amongst these Pleurocarpous mosses occurs the old (broken up by modern systematists into several genera) genus Hypnum, the largest of all the genera in these islands or in Europe—a vast group which occupies amongst mosses something like the place which the Agarics occupy amongst the Fungi.

Number of British Species.—If we were to try and ascertain the number of the British Muscineæ from the systematists of some few years ago, like Hooker and Wilson, the species would number between 500 and 600; but according to the views of more recent writers, the number would probably rise to something between 800 and 900. The true mosses are the most numerous, the turf-mosses by far the fewest.

Date of Flora.—What is the date of this moss flora of Britain? Three ancient collections enable us to give some

[1] The substance (with omissions and additions) of a Discourse by the Right Hon. Lord Justice Fry, delivered at the Royal Institution, January 23, 1891.

reply to the question. In an interglacial bed near Crofthead, in Renfrewshire, eleven species of moss were discovered, and with one possible exception all are well-defined British species of the present day. If we take Mr. Wallace's chronology, and hold that 80,000 years have passed since the Glacial epoch disappeared, and 200,000 years since the Glacial epoch was at its maximum, we may perhaps give from 100,000 to 150,000 years for the age of this little collection. Out of the eleven mosses discovered seven belong to the genus Hypnum, or the family Hypnaceæ. This collection, then, is evidence, so far as it goes, (1) that the existing moss flora is as old as the interglacial epoch; (2) that the Hypnaceæ were as dominant then as now; and (3) that the specific forms have remained constant since that epoch.

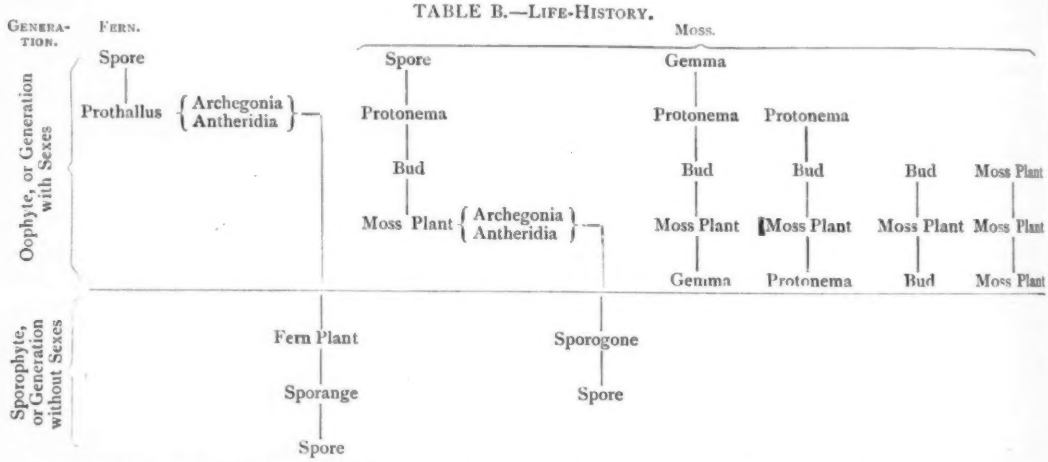
Another collection of fourteen mosses has been discovered in a drift in the Clyde valley above the Boulder drift, and tends to confirm the previous conclusions; as all the species are existing, all now inhabit the valley of the Clyde, and the Hypnaceæ are still predominant, though not in so great a proportion as in the Renfrewshire bed.

A third collection has been found at Hoxne, in Suffolk, in a lacustrine deposit, probably resting in a hollow in the boulder clay: together with phanerogams of an arctic habit have been found the remains of ten mosses, which are described by Mr. Mitten as looking "like a lot of bits drifted down a mountain stream." They are all still dwellers in our island, and exhibit, like the other collections, a preponderance of the family of Hypnaceæ.

The fossil remains of mosses are not numerous, or for the most part very ancient. Heer inferred their existence in the Liassic period, from the presence of remains of a group of small Coleoptera, the existing members of which now live amongst mosses—an inference which seems not very strong. But recently the remains of a moss have been found in the Carboniferous strata at Commentry, in France. It appears to be closely allied to the extant Polytrichum, the most highly-developed genus of mosses; so that we have here a phenomenon like that which occurs in reference to the Equisetaceæ and Lycopodiaceæ, viz. that the earliest fossil species known belong to very highly-developed forms of the group.

Life-History.—The following table is intended to illustrate the life-history of a moss in its fullest and in its abbreviated courses, and to bring this history into comparison with that of the ferns:—

TABLE B.—LIFE-HISTORY.



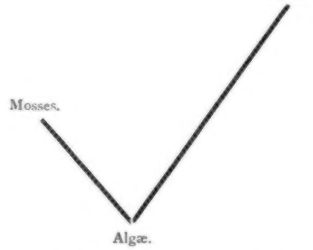
The reader's attention should first be drawn to the second column, which shows the life-history in its fullest form. It will be seen that it starts with a spore and returns to a spore.

From (1) the *spore*, which is a simple cell, proceeds (2) the protonema, a line of cells, extending by transverse divisions, so that it consists of single cells joined end to end to one another—an organism indistinguishable from the hypha of an Alga. At points this hypha throws off lateral branches which are always of less diameter than the principal ones. There is thus produced a tangled mat of fibres, running on or near the surface of the ground, and often coloured by chlorophyll. It is the green stuff so often seen in flower-pots which have been allowed to get too damp. At points in the primary hypha individual cells begin to divide in a new fashion—not by transverse septa as before, but by septa differently inclined, so as to produce the rudiments of leaves; and the direction of growth changes from horizontal to vertical. Thus is formed (3) the bud, which by growth gives rise to (4) the moss plant; on this plant, sometimes in close proximity to one another, sometimes in different parts of the same plant, sometimes on different plants, are formed (*a*) the female cell or archegonium, and (*b*) the antheridia or male organs, the antherozoids proceeding from which seek and find and fertilize the archegonium. This completes the first part of the life of the plant, the oophytic generation which results in a single sexual cell, viz. the fertilized archegonium. From this cell arises the next generation, consisting of the sporogone or stem bearing the capsule and the capsule itself, in which without fertilization are produced spores. The plant has thus started with the spore, an asexual cell, reached the point where its whole future is gathered up in a sexual cell, which has produced an organism again producing an asexual cell: we started with a spore, and have returned to a spore; we have travelled round a circle, divisible into two parts or generations, one sexual, the other asexual; and we have therefore a case of alternation of generations. To make this statement more clear, it may be observed that a generation is here spoken of as that part of the life of an organism which intervenes between the two points at which its whole future is gathered up into one cell; that such a cell is sexual when it is the result of the combination of two previously existing and independent cells; that such a cell is asexual when it is not the result of such combination; that an alternation of generations exists, whenever in the complete cycle of existence or life-history there are two points at which the whole organism is reduced to a single cell, and when the forms of the organism in the two intervals of its development are different. In the mosses, where the sporogone co-exists with and is organically connected with what I have called the moss plant, it is evident that the two generations are not such, according to the more popular notion of that word; they are not independent, nor necessarily successive.

A comparison of the first and second columns of the last table reveals at once the likeness and the unlikeness of the life-histories of the moss and of the fern. In each case the spore produces a growth of a form and nature entirely unlike the mother-plant—in one case a hypha, in the other a thallus. But whilst in the moss the protonema produces the moss plant, in the fern the prothallus itself is the home of the male and female organs, and of the sexual process, so that the fern plant belongs to the sporophytic and the moss plant to the oophytic generation; the fern plant is the result of the sexual union, whilst the moss plant is produced from the asexual spore; the fern plant produces spores asexually, the moss plant produces the sporogone as the result of the sexual union.

The observations which arise in connection with this com-

parison are numerous. (1) It is the belief of botanists, ever since the investigations of Hofmeister, that not mosses and ferns only, but all the phanerogams, go through an alternation of generations consisting of the oophytic and sporophytic generations. (2) It appears that the mosses and the Characeæ are the only groups of plants in which the conspicuous and vegetative organism—the plant, in ordinary parlance—belongs to the oophytic generation: (3) That, in consequence, the plant of the moss is in no sense the ancestor of the plant of the fern, or of the phanerogams, but belongs to a different generation from these; and further, that the leaves, the stem, and the epidermis of the moss have no genetic connection with the leaves, the stem, or the epidermis of our flowering plants, whilst the fibro-vascular bundles of the sporogone of the Polytrichum, and the stomata on the apophyses of some mosses will belong to the same generation which, in the vascular cryptogams and phanerogams, produces similar organs. (4) That the great chasm in the systematic arrangement of the vegetable kingdom between the mosses and the ferns is thus accounted for by their belonging to different generations, so that the ferns are not in any sense descendants of the mosses, but only collateral relatives, as thus—



(5) That, consequently, the mosses not only represent the highest development known of the cellular cryptogams, but the highest point in one line of development, in which the oophytic generation took the lead in importance; whilst the vascular cryptogams and phanerogams are the results of another and more successful line of development, in which the sporophytic generation took the lead as the prominent part in the life-history.

The appearance of similar organs in two independent lines of development—*i.e.* of the leaves, stem, and epidermis—in the mosses, and then in the ferns, without any relation of descent, is a thing well worthy of being pondered over by those who study evolution: it may suggest that the two lines of development, though independent, are governed by some principle which brings about such like results: it may be compared with the likenesses which occur in the animal kingdom between the placental and marsupial mammals.

The remaining columns of the table above given will best be understood after a study of the next succeeding table.

Modes of Reproduction.—Hitherto we have considered only the reproduction from a spore produced in the special organ for their production—the spore capsule. But, in fact, one of the most striking peculiarities of the mosses is the vast variety of their modes of reproduction.

In the following table, which is probably far from exhaustive, I have endeavoured to exhibit many of these modes of reproduction, dividing them into those cases in which it takes place with protonema, and those cases in which it takes place without.

TABLE C.—MODES OF REPRODUCTION.

A.—*With Protonema.*

i. Spores.	in capsule	
ii. Gemmæ ...	... on end of leaf ...	... *Leptodontium gemmascens.* *Orthotrichum phyllanthum.* *Grimmia Hartmani.*
	on midrib	... *Tortula papillosa.*
	in axils of leaves	... *Bryum.*
	in balls	... *Aulacomnion.*
	in cups	... *Tetraphis.*
iii. Protonema	... from rhizoids ...	... *Phascum.* *Polytrichum.*
	from aërial rhizoids	... *Dicranum undulatum.*
	from terminal leaves	... *Oncophorus glaucus.*
	from base of leaf	... *Funaria hygrometrica.*
	from midrib ...	... *Orthotrichum Lyelli.*
	from margin ...	... *Buxbaumia aphylla.*
	from stems... ...	... *Dicranum undulatum.*
	from calyptra ...	... *Conomitrium julianum.*

B.—*Without Protonema.*

iv. Leaf-Buds	... on rhizoids	... *Grimmia pulvinata.*
v. Leaf-Buds	... on aërial rhizoids	... *Dicranum undulatum.*
vi. Bulbs... ...	... on stem	... *Bryum annotinum.*
vii. Young Plants	... at ends of branches	... *Sphagnum cuspidatum.*
viii. Leafy Branches.	becoming detached	... *Conomitrium julianum.* *Cinclidotus aquaticus.*
ix. Rooting of main axis	... ...	*Mnium undulatum.*

Weismann's Theory.—The consideration of this table is not without its interest in reference to Prof. Weismann's theory of the division of the cells and plasma of organisms into two kinds: the germ cells and germ plasma endowed with a natural immortality, and the somatic cells and somatic plasma with no such endowment. That the mosses are a difficulty in the acceptance of the theory as a universal truth, the Professor himself admits. The evidence of the mosses seems to amount at least to this: that in this whole group, the highest in this line of development, where the oophytic generation produces the principal plant, and where there are highly specialized organs for the production of spores or germ cells—that in this whole group either there is no effectual separation between the two kinds of plasma, or that the germ plasma is so widely diffused amongst the somatic plasma that every portion of the plant is capable of reproducing the entire organism.

Comparison with Zoological Embryology.—The table will further offer us some points of comparison with animal embryology.

In that branch of physiology, one of the most remarkable facts is what has been called recapitulation, *i.e.* the summary in the life of the individual of the life of the race, so that the development of the individual tells the development of the race—*e.g.* the gills of the tadpole tell us of the descent of the Batrachians from gill-breathing animals.

So here we cannot doubt that the protonema of the moss tells us of the descent of the whole group of mosses from the Algæ.

Another remarkable fact in animal embryology is the coexistence in exceptional cases of the mature and the immature form; so the axolotl retains both gills and lungs throughout its life. In like manner some mosses, *e.g.* the *Phascum*, retains its algoid protonema throughout its life.

Again, in zoological embryology, an attempt is often found, to use the language of Prof. Milnes Marshall,[1] "to escape from the necessity of recapitulating, and to substitute for the ancestral process a more direct method."

In like manner the preceding tables will show to how great an extent Nature has adopted the system of short-circuiting in the reproduction of the mosses; for in every mode of reproduction, except that through sporogone and spore, it will be observed that a shorter circuit is travelled, *e.g.* the *Orthotrichum phyllanthum* produces spores at the end of its leaves, which, falling to the ground, throw out a protonema which produces a bud, and then a moss plant, and then a spore at the end of the leaf, and the whole sporophytic generation is evaded; and so on in gradually shortening circles (see Table B), till we get the case of a Sphagnum, which produces a little Sphagnum plant at the end of its leaves without protonema—whether without bud, I do not know. In every case Nature seems to leave out the sexual reproduction if she can help it, and directs her whole attention to the production of the vegetative organism—the moss plant in the popular sense—which she never omits.

Another point of comparison arises, but this time it is one of contrast between the embryology of the two kingdoms.

In animals, to again quote Prof. Milnes Marshall, "Recapitulation is not seen in all forms of development, but only in sexual development, or at least only in development from the egg. In the several forms of asexual development, of which budding is the most frequent and the most familiar, there is no repetition of ancestral phases, neither is there in cases of regeneration of lost parts."

In mosses, on the contrary, the table last given shows that in most of the modes of reproduction, the ancestral form, the algoid protonema, is retained and reproduced, whereas in the growth from a sexual cell, *i.e.* in the sporogone, the ancestral form entirely disappears.

The peristome, or girdle of teeth round the orifice of the capsule, assumes very varying forms, often of great beauty and interest. In some of the mosses it is absent, in some it consists

[1] Address to Biological Section of British Association (NATURE, vol. xlii. p. 478).

of one ring of teeth, in many of two rings, and in one foreign genus (Dawsonia) there are as many as four circles of teeth.

The object served by this complicated structure is not, perhaps, very certain, but it seems to be intended to secure the retention or exclusion of the spores from the spore sac in such conditions of the atmosphere as will best conduce to their germination. In the gymnostomous mosses (*i.e.* those without peristome) it is observed that the spores sometimes germinate within the capsule, an event which is probably adverse to the prospects of the race. The following table will illustrate in a few cases selected as illustrations the different behaviour of the teeth of the peristome under different hygrometric conditions, and suggests what is the probable advantage in each case:—

TABLE D.

Genus.	Condition of teeth		Reason suggested.
	in dry weather.	in wet weather.	
Bartramia ...	Erect ...	Convergent	That spores require *dry* weather when first emitted
Orthotrichum.	Erect or reflexed ..	Ditto ..	Ditto
Funaria ...	Reflexed ...	Ditto ...	Ditto
Bryum ...	Convergent...	Expanded..	That spores require *wet* weather when first emitted
Fissideus ...	Ditto ...	Ditto ...	Ditto

The motion of the teeth of the peristome appears to be due to the action of a ring of specialized cells which surrounds the mouth of the capsule at the base of the teeth; and the opposite ways in which these cells act in the same condition of moisture in different genera, is a remarkable circumstance.

To anyone who studies the subject, the immense variety as well as beauty of the peristomes of mosses becomes very impressive. If the sole end be the protection and extrusion of the spores in the proper weather respectively, why is there this infinite wealth and variety of form and of colour? The question can be asked, but hardly can be answered, and the mind of the beholder is left, as it so often is, when contemplating the richness of Nature, in a state of admiration and wonder and ignorance. "Rerum natura tota est nusquam magis quam in minimis."

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The regulations for the new Isaac Newton Studentships for study and research in astronomy and Physical Optics are published in the *University Reporter* for February 17, 1891. Mr. Frank McClean, the generous founder, has increased his benefaction to £12,500.

The Museums and Lecture Rooms Syndicate report that a sum of £1450 will be required for the fittings of the new buildings in the Departments of Human Anatomy and Physiology.

The following have been nominated as electors to the Professorships indicated;—Chemistry, Sir H. E. Roscoe; Plumian, Dr. Cayley; Anatomy, Prof. Liveing; Botany, Dr. Vines; Geology, Dr. Bonney; Jacksonian of Natural Philosophy, Prof. Ewing; Mineralogy, Dr. Bonney; Zoology and Comparative Anatomy, Sir G. M. Humphry; Cavendish of Physics, Prof. Liveing; Mechanism, Dr. Besant; Downing of Medicine, Sir G. M. Humphry; Physiology, Sir G. E. Paget; Pathology, Sir G. E. Paget; Surgery, Sir G. E. Paget.

Prof. A. G. Greenhill, F.R.S., and Dr. Routh, F.R.S., are nominated as adjudicators of the Adams Prize to be awarded in 1893.

Mr. Hickson, the newly-appointed Lecturer in Invertebrate Morphology, announces a course on *Cœlenterata* to be given during the remainder of the current term.

SCIENTIFIC SERIALS.

THE *American Meteorological Journal* for January contains:—A report upon the features of tornadoes, and their distinction from other storms, considered in connection with the tornado of Lawrence, Mass., July 26, 1890, by Prof. W. M. Davis. He quotes a description of a tornado observed as early as 1687 at Hatfield, in this country, in which the writer (the Rev. A. de la Pryme) minutely describes the whirling motion of the funnel.—The meteorological observatory recently established on Mont Blanc, by A. L. Rotch. This is a reproduction of a paper read before Section A of the British Association last year, and contains a description of a meteorological observatory being erected by M. Vallot at the Rocher des Bosses, at an altitude of about 14,320 feet above sea-level.—The Gervais Lake tornado, by P. F. Lyons. It occurred on July 13, 1890, and did immense damage to buildings and crops, over an area of scarcely more than half a mile in length. The editors of the *Journal* have added what purports to be a photograph of the funnel, taken by an amateur photographer, who happened at the time to be occupied in taking views, about six miles off.—Rainfall in Michigan, by N. B. Conger, with a chart showing the annual fall in that State. This paper closes a series of monthly summaries by the same author.—Prof. H. A. Hazen concludes his account of observations on Mount Washington; and M. H. Faye concludes his articles on cyclones, tornadoes, and waterspouts, which were begun in the number for November 1889, and probably form the most complete exposition of his theory which has yet been printed. The editors of the *Journal* invite the criticism of English-speaking meteorologists.

THE *Journal of Botany* has been recently distinguished for the unusual interest of its biographical notices of recently deceased botanists, or those interested in botanical pursuits. In the numbers for November and December 1890, we find such records of the late Miss Marianne North, whose beautiful flower-paintings are so familiar to visitors at Kew, and of the late Mr. James Backhouse, of York. The other papers in these numbers and in that for January 1891 are mostly either descriptive, or relate to the habitats of rare plants. Mr. John Roy gives a list of freshwater Algæ from Enbridge Lake and its vicinity in Hampshire; Mr. E. G. Baker continues his synopsis of genera and species of Malveæ; Mr. G. Massee describes and figures a remarkable new genus of Hymenomycetous Fungi from Madagascar, *Mycodendron*.

THE two most important papers in the *Botanical Gazette* for January are a continuation of Mr. J. Donnell Smith's "Undescribed Plants from Guatemala," which include a new species of *Cephaelis*, and one by Mr. R. Thaxter on "Certain new or peculiar North American Hyphomycetes," in which a new genus of Fungi, *Sigmoideomyces*, is described, allied to *Oedocephalum*.

THE number of the *Nuovo Giornale Botanico Italiano* for January is chiefly occupied by papers read at the Verona annual meeting of the Italian Botanical Society. Neither these, nor the independent papers printed in this number, present any features of special interest to the general botanist.

WE have received the numbers for October, November, and December 1890 of the *Botanical Magazine* of Tokio, which give satisfactory evidence of the cultivation of botanical science in the Empire of Japan. The *Magazine* is published monthly, under the auspices of the Tokio Botanical Society, and is printed on rice paper. By far the greater number of the contributions are in Japanese, while others are in what we take to be Japanese printed in English characters. Those in English are chiefly by Prof. R. Yatabe, the President of the Tokio Botanical Society, and include descriptions of several new Japanese species, and of a new genus, *Kirengeshoma*, belonging to the Saxifragaceæ. The illustrations to a paper (in English) by Mr. N. Tanaka, on two new species of Japanese edible fungi, are particularly good.

SOCIETIES AND ACADEMIES.

LONDON.

Zoological Society, January 20.—Mr. W. T. Blanford, F.R.S., in the chair.—Mr. Sclater exhibited specimens of three species of Purple Waterhens (*Porphyrio poliocephalus*, *P. cæruleus*, and *P. smaragdonotus*), of the Eastern Palæarctic Region,

and made remarks on their nomenclature and geographical distribution.—Mr. F. E. Beddard described a new African Earthworm of the genus *Siphonogaster* from specimens transmitted by Sir A. Molony, from the Yoruba country to the north of Lagos, and proposed to call it *Siphonogaster millsoni*.—Mr. Oswald H. Latter read some notes on the Fresh-water Mussels of the genera *Anodon* and *Unio*, describing the passage of the ova from the ovary to the external gills, the mode of attachment of the *glochidia* to the parent's gill-plate, and some other peculiarities. —A communication was read from Mr. Roland Trimen, F.R.S., containing an account of a series of Butterflies collected in Tropical South-Western Africa by Mr. A. W. Eriksson. The collection contained examples of 125 species, of which 11 appeared to be new to science.—A communication was read from Mr. H. H. Brindley, containing an account of a specimen of the White Bream (*Abramis blicca*), in which the pelvic fins were entirely absent.—Mr. Boulenger read notes on the osteology of the poisonous Lizards *Heloderma horridum* and *H. suspectum*, pointing out the differences between the two species. He also remarked on the systematic position of the *Helodermatidæ*, which he held to be between the *Anguidæ* and the *Varanidæ*, but nearer the former; any close relationship with the *Mosasauridæ* was demurred to. It was incidentally mentioned that the Eocene genus *Thinosaurus*, Marsh, was probably a member of the family *Teiidæ*, and that the Cretaceous *Hydrosaurus lesinensis* was a *Dolichosaurus*. The Dolichosauria were considered as the probable common ancestors of the Lacertilia, Pythonomorpha, and Ophidia.—Prof. C. Stewart gave an account of some points in the anatomy of *Heloderma horridum* and *H. suspectum*, differing in some respects from the descriptions of these lizards given previously by Drs. Fischer and Shufeldt. The most interesting and important point was concerning the poison-apparatus. He believed that he had shown that in both species the ducts of the gland did not enter the lower jaw, but passed directly to openings situated under a fold of mucous membrane between the lip and the jaw. He thought that the structures previously described as ducts were only the branches of the inferior dental nerve- and blood-vessels.

Geological Society, February 4.—Dr. A. Geikie, F.R.S., President, in the chair.—The following communications were read:—The geology of Barbados and the West Indies; Part 1, the coral rocks, by A. J. Jukes-Brown and Prof. J. B. Harrison. The authors first discuss the reef growing round Barbados, and describe a submarine reef, the origin of which is considered; and it is pointed out that there is no sign of any subsidence having taken place, but every sign of very recent elevation. They then describe the raised reefs of the island, extending to a height of nearly 1100 feet above sea-level in a series of terraces. The thickness of the coral rock in these is seldom above 200 feet, and the rock does not always consist of coral *débris*. At the base of the reefs there is generally a certain thickness of detrital rock in which perfect reef-corals never occur. The collections of fossils made by the authors have been examined by Messrs. E. A. Smith and J. W. Gregory. Of the corals, 5 out of 10 species identified still live in the Caribbean Sea, and 1 is closely allied to a known species, whilst the other 4 are only known from Prof. Duncan's descriptions of fossil Antiguan corals. The authors are of opinion that the whole of the terraces of Barbados, the so-called "marl" of Antigua, and the fossiliferous rocks of Barbuda are of Pleistocene age. They proceed to notice the formations in other West Indian Islands which appear to be raised reefs comparable with those of Barbados, and show that these reefs occur through the whole length of the Antillean Chain, and indicate a recent elevation of at least 1300 feet, and in all probability of nearly 2000 feet. It appears improbable that each island was a region of separate uplift, and as a plateau of recent marine limestone also occurs in Yucatan, this carries the region of elevation into Central America; and it is reported that there are raised reefs in Colombia. The authors conclude that there has been contemporaneous elevation of the whole Andean Chain from Cape Horn to Tehuantepec, and of the Antillean Chain from Cuba to Barbados. Before this there must have been free communication between the Atlantic and Pacific Oceans, which is confirmed by the large number of Pacific forms in the Caribbean Sea. Under such geographical conditions the great equatorial current would pass into the Pacific, and there would be no Gulf Stream in the North Atlantic. The reading of this paper was followed by a discussion, in which the Rev. E. Hill, Mr. Attwood, Mr. Gregory, Mr. W. Hill, Mr. Easton, Dr. Blanford, and the President took part. The President remarked that the details supplied in the paper formed an important addition to the literature of the coral-reef question, showing as they did clear evidence of the elevation of old coral-reefs. He thought the speculations appended by the authors as to the changes in the level of the South American continent and Central America somewhat out of place, and hardly warranted by any of the observations recorded in the paper. No trifling submergence of the Isthmus of Panama would serve to divert the great equatorial current into the Pacific Ocean. Unless the downward movement had been more serious than the authors seemed to suppose, the bulk of the current would still sweep round into the Gulf of Mexico, only the upper waters passing into the Western Ocean.—The shap granite, and the associated igneous and metamorphic rocks, by Alfred Harker and J. E. Marr.

Entomological Society, February 4.—Mr. Frederick DuCane Godman, F.R.S., President, in the chair.—The President nominated the Rt. Hon. Lord Walsingham, F.R.S., Prof. R. Meldola, F.R.S., and Dr. D. Sharp, F.R.S., Vice-Presidents for the session 1891–92.—Mr. C. J. Gahan called attention to a small larva which he had exhibited at the meeting of the Society on October 1 last, when some doubt was expressed as to its affinities. He said that Prof. Riley had since expressed an opinion that the larva was that of a dipterous insect of the family *Blepharoceridæ*, and might probably be referred to *Hammatorrhina bella*, Löw, a species from Ceylon.—Mr. Tutt exhibited a long series of *Agrotis pyrophila*, taken last year by Mr. Reid, near Pitcaple, in Aberdeenshire, and he remarked that this species had been commoner than usual last year both in Scotland, the Isle of Portland, and the Isle of Man. He also exhibited long and variable series of *Melitæa aurinia* (*artemis*), *Triphæna orbona*, *Abraxas grossulariata*, and *Melanippe fluctuata*, all from the same locality in Aberdeenshire.—The Rev. Canon Fowler exhibited a cocoon of *Deiopeia pulchella*, recently received by him from Lower Burmah.—Mr. C. O. Waterhouse exhibited specimens of *Scyphophorus interstitialis*, a Mexican species, and *Aceraius comptoni*, a Ceylon species, recently taken by Mr. Bowring in his greenhouse. He also exhibited, on behalf of Miss Emily Sharpe, a specimen of *Daphnis hypothous*, Cramer, a native of Borneo, Java, and Ceylon, caught some years ago at Crieff, N.B. The specimen had long been confused with *Chærocampa nerii*, under which name its capture was recorded in the *Entomologist*, xiii. p. 162 (1880).—The Rev. Dr. Walker exhibited many species of Orthoptera and Scorpions recently received from Jerusalem.—Mr. Frederick Enock read an interesting paper entitled "The Life-History of the Hessian Fly." This paper was illustrated, by means of the oxy-hydrogen lantern, with a number of photographs of original drawings showing the fly in all its stages and transformations. Mr. G. H. Verrall said he believed the Hessian Fly was no more a recent introduction into this country than the Cabbage White Butterflies.—Mr. Roland Trimen, F.R.S., communicated a paper entitled "On some Recent Additions to the List of South African Butterflies."—Mr. Henry W. Bates, F.R.S., communicated a paper entitled "Additions to the Carabideous Fauna of Mexico, with remarks on species previously recorded."—Mr. W. F. Kirby read a paper entitled "Notes on the genus *Xanthospilopteryx*, Wallgr."—Dr. D. Sharp, F.R.S., contributed a paper entitled "On the Rhynchophorous Coleoptera of Japan," Part 2.

Linnean Society, February 5.—Prof. Stewart, President, in the chair.—Mr. Clement Reid exhibited and described some recent additions to the fossil Arctic flora of Britain.—Mr. Thomas Christy exhibited and made remarks on some specimens of honey: (1) "Arbutus honey," from Turkey, said to produce great drowsiness and sleep; (2) "Eucalyptus honey," from Mount Barker, Adelaide, said to possess valuable therapeutic properties; and (3) so-called "wool honey," from the Euphrates, collected by natives from the leaves of the oak, which would be more properly termed "honey-dew," being formed by Aphides, and not by bees.—Mr. J. E. Harting exhibited a living albino example of the Common Frog (*Rana temporaria*), captured in Wiltshire in September last, and remarked upon the infrequency of albinism amongst the Batrachia and Reptilia, of which he had only been able to find four or five recorded instances.—On behalf of Mr. Gammie, of Sikim, Mr. C. B. Clarke gave an abstract of an interesting paper on the tree ferns of Sikim, in which several moot points were discussed and

difficulties cleared up.—The next paper was one by Prof. W. A. Herdman, on a revised classification of the *Tunicata*. Taking as a basis the scheme of classification adopted in his Report on the *Challenger* collection, he incorporated the various known genera and species not represented in this collection, and discussed the general principles to be recognized in classifying the *Tunicata*, especially dwelling on the value of the various modifications of the branchial sac, and of the tentacles. The polyphyletic origin of the group *Ascidiæ Compositæ* was pointed out, and the relations between Simple and Compound Ascidians were shown by means of a phylogenetic diagram.—A paper was then read by Prof. G. B. Howes, in which he gave a description of the genitalia of six hermaphroditic codfish examined by him, and a *résumé* of what is known on the general subject of hermaphroditism amongst fishes, more particularly referring to the *Teleostei*, which exhibited the most nearly primitive condition of the genital gland realized by living Vertebrata. He regarded the genital duct of the *Teleostei* as homologous in both sexes, representing a primitively hermaphrodite duct of the ancestral Chordata. He sought to homologize it with the proliferating mass described by Balfour and Sedgwick, Fürbringer and others, as entering into the formation of the base of the Müllerian duct proper, and regarded it as having been replaced by that structure on the advent of unisexuality. Several other points were touched upon of special interest to physiologists, and which want of space alone prevents being noticed.

Mathematical Society, February 12.—Prof. Greenhill, F.R.S., President, in the chair.—The Chairman informed the members present of the loss the Society had sustained by the recent death of Dr. Casey, F.R.S., and called upon Mr. Tucker to read a short obituary notice which had been drawn up by an intimate friend of the deceased. Dr. Larmor added a few sympathetic remarks.—Mr. Tucker communicated two notes on isoscelians, and Mr. Heppel read a paper on quartic equations interpreted by the parabola.—The Chairman read a note from Mr. W. E. Heal, of Indiana (communicated by Prof. Cayley, F.R.S.), on the equation of the bitangential of the quintic.—Mr. Tucker read an abstract of a paper by Mr. J. Buchanan, on the oscillations of a spheroid in a viscous liquid.

CAMBRIDGE.

Philosophical Society, January 26.—Prof. G. H. Darwin, President, in the chair.—The following communications were made:—On the electric discharge through rarefied gases without electrodes, by Prof. J. J. Thomson. A vacuum tube was exhibited in which an electric discharge was induced by passing the discharge of Leyden jars through a thread of mercury contained in a glass tube coiled four times along it. The induced discharge was found to be confined to the part of the vacuum tube which was close to the primary discharge, and it did not show striæ. It was also demonstrated that an ordinary striated discharge is strikingly impeded by the presence of a strong field of magnetic force.—On diffraction at caustic surfaces, by Mr. J. Larmor. A caustic surface is physically a result of diffraction, and consists of a series of parallel bright sheets whose distances apart are always in the same proportion, and at different places are absolutely proportional to the cube root of the curvature of the sheets in the direction of the rays, for light of given wavelength. The general character of the appearances is illustrated entoptically when the light that has passed through a water-drop on a glass plate is received into the eye, so that the caustic surface intersects the retina in a caustic curve, usually cusped.—The effect of temperature on the conductivity of solutions of sulphuric acid, by Miss H. G. Klaassen (communicated by Prof. J. J. Thomson. The viscosity of sulphuric acid solutions reaches a maximum at a dilution corresponding to a hydrate, $H_2SO_4 . H_2O$. The electric resistance shows the same general characteristics. The resistance curves are plotted for different temperatures, and show that the effect diminishes with rise of temperature, and finally tends to evanescence, a result which would be accounted for by gradual dissociation of the hydrate.

PARIS.

Academy of Sciences, February 9.—M. Duchartre in the chair.—On Herr Wiener's experiment, by M. H. Poincaré. The author gave some mathematical objections to the theory proposed by M. Cornu to explain Herr Wiener's experiments on the direction of vibration in a beam of polarized light (*Comptes Rendus*, January 26).—Note by M. Berthelot, *à propos* of the preceding communication.—M. E. Becquerel submitted some of his photographic reproductions of the solar spectrum obtained more than forty years ago.—Determination of the masses of Mars and Jupiter by meridian observations of Vesta, by M. Gustave Leveau. The tabulated differences between observed and calculated places of Vesta show that the introduction of the secular perturbing influence of the asteroids does not sufficiently modify the residuals to take account of it in the formation of the tables of Vesta, but that the masses of Jupiter and Mars necessitate an appreciable correction.—On the conductivity of tribasic organic acids; a new characteristic of basicity, by M. Daniel Berthelot. It is shown that measurements of electrical conductivity furnish a new characteristic for the determination of the basicity of acids when their molecular weights are known.—On the combinations formed by ammonia with chlorides, by M. Joannis. Compounds of ammonia with chlorides of sodium, potassium, and barium, are described.—On the formation of isopurpurates, by M. Raoul Varet.—On the mode of combination of sulphuric acid in plastered wines, and on the detection of free sulphuric acid, by M. L. Magnier de la Source.—An olfactometer founded on the principle of diffusion across flexible membranes, by M. Charles Henry. The use of the instrument is to determine the weight of any odoriferous vapour per cubic centimetre of air, which corresponds to the minimum of perceptibility.—Action of certain substances used in medicine, and in particular of extract of valerian, on the destruction of glucose in the blood, by M. L. Butte.—On the manners and metamorphoses of *Emenadia flabellata*; facts relating to the biological history of Rhipiphori, by M. A. Chobaut.—On the development of the fins of *Cyclopterus lumpus*, by M. Frédéric Guitel.—A new fossil Cycad, by M. Stanislas Meunier.—On the coal basin of Boulonnais, by M. Gosselet.—On the presence of Upper Devonian in the Ossau valley (Lower Pyrenees), by M. J. Seunes.

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